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ABSTRACT

The Outdoor Biology Instructional Strategies (OBIS) Trial Edition Set I contains 24 varied activities which make use of crafts, simulations, and basic investigative techniques to provide introductory learning experiences in outdoor biology for children aged 10 to 15. The individual water-resistant folio for each activity includes biological definitions and concepts, materials list, preparation, action, discussion, follow up, and suggested subsequent activities. Among the activities are studies of animal movement in water, leaves, natural recycling in soil and in water, seed dispersal, ponds, natural camouflage, and predator devices. Making sun prints, mapping a study site, plant hunts, and introductory census activities are also included. Set I includes 3 introductory folios. "What is OBIS?" explains the project's governing concepts and goals. The "Leader's Survival Kit" notes good activity sites, sample activity sequences, and safety information. An "OBIS Tool Box" contains Equipment and Technique Cards giving instructions for building and using various inexpensive equipment such as plankton nets and weed grapples. Instructions for each device are complete on one card. Finally, there are 2 booklets, a Pond Guide and a Lawn Guide, designed for quick and easy identification, via pictures, written descriptions, and size scales, of the most commonly encountered organisms in those locations. (SB)

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OUTDOOR BIOLOGY INSTRUCTIONAL STRATEGIES TRIAL EDITION

SET I

RC 011 194

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WHAT IS OBIS?

Outdoor Biology Instructional Strategies offers both independent and sequential activities to promote the understanding of ecological relationships by youngsters from ten to fifteen years of age. The major goal of OBIS is to design instructional strategies for learning experiences in outdoor biology that can be applied in diverse environments.

OBIS activities are primarily oriented toward community-sponsored youth organizations and nature centers. The activities introduce basic concepts of ecology in interest-catching ways. Youngsters investigate the interrelationships and interactions of plants, animals, and the physical environment, including man's role in the natural scheme. Such firsthand experience forms the basis for the understanding of basic biological relationships. This understanding is necessary to develop the public consciousness required to support appropriate management of man's environment.

WHY OBIS?

The relationship between man and his environment has reached a crisis. Man for too long considered himself independent of nature, free to take what he wanted and change what did not suit his purposes. For centuries the environment withstood man's abuse; the planet was large and man's population, controlled by natural catastrophy, disease, famine, and conflict, was small. However, man prospered; his capacity to learn from experience and make changes in his environment insured continual "progress." Medicine and technology produced a greater chance of survival, and ever-increasing comfort and convenience. As man's population increased, the planet seemed to shrink, but often man remained indifferent to his long-term effects on plants, animals, soil, air, and water. We have reached the point where we can no longer ignore the ecosystem which supports us. We now realize that it is possible to exhaust the available supply of many natural resources.

We cannot continue to alter the face of the planet with wholesale disregard for the environment. Only by changing our way of life can we live compatibly with the other life forms in the environment. The general populace must have considerable environmental knowledge if basic attitudes and customs are to be changed to embrace new concepts of our relationship with nature.

IT'S A BIOLOGICAL WORLD!

Man is a part of the life-sustaining system that includes the sun, plants and animals, soil, oceans, lakes and streams, and the atmosphere. Plants and animals interact with each other and with the soil and the atmosphere. The sun's energy sustains these interactions through **photosynthesis**, the process by which plants capture the sun's energy and manufacture food to support both the plants' and animals' life processes.

Animals, however, cannot make food; they must obtain their food by eating plants or other animals. The transfer of food from plants to plant eaters to animal eaters is called a **food chain**. The transfer and use of food made by plants does not end with animal eaters (predators). When organisms die, their bodies may be eaten by scavengers as diverse as worms and vultures.

Food Chains

Plant and animal tissues not eaten by scavengers are consumed by fungi, molds, bacteria, and many kinds of small animals. In the process of obtaining food, these organisms decompose the dead organic matter and eventually reduce it to minerals, water, and carbon dioxide. These materials, returned to the earth, water, and atmosphere, can then be used again by plants to produce food. This process is called **natural recycling.**

Population, Community, Ecosystem

Each group of organisms of the same kind that lives and reproduces in a particular area is a **population**. Populations of plants, of plant eaters, of scavengers, and of molds and bacteria live together and depend on each other for food and protection. Such a combination of interdependent populations is called a **community**.

Communities differ depending on their locations. A pond community lives in a pond and consists of different kinds of plants and animals adapted for living in a pond. Oceans, tidepools, lakes, streams, prairies, deserts, and forests all represent communities that differ according to the physical surroundings (**environment**) in which they live, and the populations of plants and animals that make up the community. The lawn that surrounds your house is a community as is the city park or vacant lot. You do not have to travel long distances into the "wilds" to find natural communities.

The organisms that make up communities are dependent not only on each other, but also on the environment in which they live. While all organisims need water, oxygen, and food, plants need sunlight, carbon dioxide, and minerals to manufacture food. Temperature, humidity, and day lengths are also important. The interaction of the organisms of a community with the environment of light, soil, air, and water in which they live creates an interdependent unit of living and non-living elements called an **ecosystem**. The ecosystem is not something you can go out and touch or handle. You can see, touch and handle only the parts, such as the plants, animals, water, soil, etc. The ecosystem is the sum of these parts and their interaction.

Adapting to a Habitat

Within the ecosystem there are other organizing concepts and interactions which are universal wherever there is life. **Adaptations** are special features or behaviors which improve an organism's chances of surviving and reproducing. Some animals display color adaptations which allow them to blend into their surroundings; hen ducks are the same mottled brown color as the dead rushes in which they nest. Other adaptations permit plants and animals to secure food, reproduce, move through their environment, and defend themselves. The sum of all of the adaptations displayed by an organism determines the habitat in which the organism lives. A **habitat** is the place where an organism normally lives and where you would ordinarily go to find it. An animal that is adapted to extract oxygen from water, has fins for maneuvering, and can tolerate relatively warm water, might be expected to live in a shallow pond habitat. A plant that can withstand high temperatures and low moisture might be found in a desert habitat.

If a habitat undergoes a radical change as a result of natural catastrophy (flood, fire, landslide, drought) or the intervention of man (land clearing, swamp draining, construction), the new life conditions may no longer support the varieties of life that were previously present. New plants and animals adapted to the new conditions will colonize the changed habitat. These first colonizers may not be adapted to compete with some of the organisms which follow later, and may fail and be replaced by still other organisms.

WHAT IS OBIS?

Life Cycles

Every species must reproduce in order to perpetuate its kind. The process by which an organism comes into being, grows and matures, and produces eggs, seeds, or their equivalent, which in turn become young organisms to repeat the pattern, is called the **life cycle**. Some life cycles are simple; some complex. Some life cycles are short, as in the case of a mosquito which may go through its life cycle in a matter of a few days, while others are long, as in the case of some trees that may take years to mature sufficiently to reproduce.

Man

One organism that lives in many ecosystems and influences countless communities is man. Man alone is able to survive in a wide range of environments. This range is due primarily to the advanced abilities of his brain, an adaptation which has allowed him to dominate all other life forms. Man's brain, and a second important adaptation, the opposing thumb, make it possible for man to manipulate any environment in order to provide himself a suitable habitat, and also to defend and feed himself using other tools created from materials in his environment. With these special abilities must come greater responsibility for the consequences of his actions. Take a simple example: a man goes into the woods to go camping. He catches a fish for dinner. If he were a bear or a raccoon he would simply eat the fish. But man doesn't generally eat fish raw; he cooks it. So he gathers some wood and starts a fire. Carelessness can lead to the catastrophe of a forest fire. Even with care, the cover and food source for many organisms is often squandered cooking the fish. Gases and moisture are released into the atmosphere, but the minerals are displaced from the natural place and concentrated in an ash pile. The ashes are caustic, harboring no life until rain and wind dilute them and once again they are mineral nutrients for plants to use.

It is clear that the time has come for worldwide adoption of sensible management practices which can come only after an understanding of the processes of ecology. OBIS provides one avenue for young people to reach this understanding.

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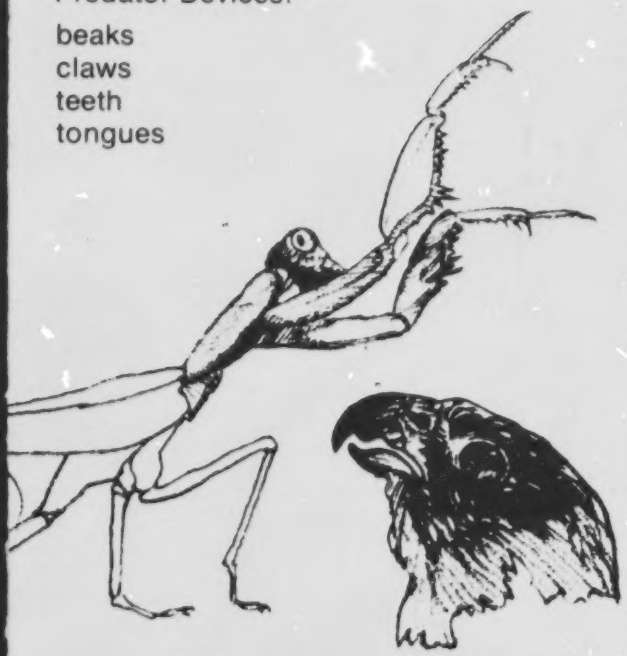
Predator Devices:

beaks
claws
teeth
tongues



Communities of plants and animals always include predators and prey. Predators have adaptations, enabling them to capture and eat their prey. In this activity these adaptations are referred to as **predator devices**.

A predator device is only one type of animal adaptation. An **adaptation** is any special feature of an organism that improves its chances of surviving and reproducing.

CREATE PREDATOR DEVICES THAT CAN CATCH AND PICK UP PREY. BE CAREFUL NOT TO INJURE ANY LIVING PLANTS OR ANIMALS.

MATERIALS

toothpicks
popsicle sticks
rubber bands
glue
scotch tape
string
pins
paper fasteners
cardboard
wire
pipe cleaners
natural materials found at study site

Action Card
PREDATOR PREY

Outdoor Biology Instructional Strategies

Make a predator device that could catch a flying insect.

Action Card
PREDATOR PREY

Outdoor Biology Instructional Strategies

Make a predator device that could dig up roots.

Action Card
PREDATOR PREY

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Make a predator device that could pick up leaves.

Action Card

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Action Card
PREDATOR PREY

Make a predator device for breaking nuts and eating the meats.

Action Card
PREDATOR PREY

Make a predator device for getting at animals that live underground.

Action Card
PREDATOR PREY

Make a predator device that could catch or pick up an egg.

Action Card
PREDATOR PREY

Make a predator device that a meat eater would use.

ADAPTATION-PREDATOR-PREY

ACTION

Take the group to any outdoor study area, such as a field, stream, woodlot, lawn or vacant lot. Assign study areas. Ask the participants to locate any materials in their plot which might be "prey" (food) for animals living in, or passing through the area. (Seeds, eggs, roots, vegetation, insects, slugs, worms, mice and other organisms may be prey).

When prey have been isolated, have participants try to build simple devices analogous to the claws, beaks, and jaws of likely predators. Use simple materials such as those on the materials list, and whatever can be found "on location" at the study site.

If you wish to provide more direction for participants, distribute an Action Card to each. Every participant can then try to build a predator device to meet the challenge on his card.

- ☐ Make a predator device that could catch or pick up an egg.
- ☐ Make a predator device that could catch a flying insect.
- ☐ Make a predator device that could dig up roots.
- ☐ Make a predator device that could pick up leaves.
- ☐ Make a predator device for getting at animals that live underground.
- ☐ Make a predator device that a meat eater would use.
- ☐ Make a predator device for breaking nuts and eating the meats.

Whatever approach is used, participants will enjoy demonstrating their devices to the group after finishing construction.

WHAT DO YOU THINK?

Why are there so many different kinds of predator devices?
What would happen if every animal had the same predator device?
What adaptations do prey have so as to avoid being eaten by predators?

FOLLOW UP

Have everyone look for predators in the study site and decide what kind of prey they are adapted to eat.

WHAT TO DO NEXT

Invent an Animal
Animal Movement in Water
Who Goes There?

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For most animals, movement is necessary for survival. To survive and maintain their own kind, animals must move to obtain food and avoid being eaten until they can mate. An animal's type of movement varies according to its needs for survival. For example, a fish has fins and a bird has wings for moving from place to place. A frog lies quietly in wait for its prey, while a mosquito fish takes active pursuit.

After participants investigate relationships between animal movement and life requirements, introduce the term **adaptation.** An **adaptation** is any special feature of an organism that improves its chances of surviving and reproducing.

In this activity, youngsters choose an aquatic animal to investigate. Each participant places his animal in a container filled with clear water and, by observing its behavior, tries to discover which structural features are involved in the animal's form of movement. After study of the animal's movement, investigations are conducted of the animal's responses to organisms and non-living objects taken from its environment.

DISCOVER HOW SOME AQUATIC ANIMALS MOVE THROUGH WATER.

MATERIALS

For each buddy team of two:

1 *Pond Guide*
2 Bug Boxes or magnifying lenses*
2 clear-plastic bags or drinking cups*
2 spoons*
1 white-bottomed container such as a dishpan or a milk carton opened on one side*
1 dip net*

*See the "Basic Aquatic Equipment" card in the *OBIS Toolbox* folio.

Note: Certain hard-to-get items, such as Bug Boxes, are available from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

PREPARATION

Select a pond or section of a pond where the sides are not too steep or slippery. Plan and institute a buddy system in which each student assumes responsibility for his teammate.

ANIMAL MOVEMENT IN WATER

ACTION

1. Divide the group into teams of two.
2. Ask each team to use a dip net and capture two pond animals for temporary observation. Each member of a team should study a different organism.
3. Each participant places his animal in a white-bottomed container filled with clear pond water. He can use a plastic spoon to transfer small animals into clear plastic cups for close viewing. Bug Boxes are useful for observing very tiny animals or small parts of animals.
4. Set the containers in shade and observe the animal's movement. Each participant should note his animal's general form of movement: does it crawl, wiggle, swim, skitter? which structures enable the animal to move?
5. To expand this investigation, each youngster can manipulate his water-filled container by adding various physical objects such as small rocks or sticks (but not mud since it clouds the water). Then, other organisms can be introduced. The objects and additional organisms are added one at a time so that the animal's reaction to each addition can be observed. Observations are usually more interesting if non-living objects are added first, followed by plants and animals taken from the study animal's environment. Care should be taken to minimize handling and jarring the animal as the system is manipulated.
6. Remind the youngsters that animals are only removed temporarily; after observation, the animals should be returned to their source.

FOLLOW THROUGH

Ask the participants to describe their animal's movements. This can be done by playing Charades: each child imitates the movements of his or her organism, and the rest of the group tries to figure out the organism's identity.

Next, ask how movement might help an animal survive. To make this question more meaningful, ask them how movement helps *them* to stay alive (food, warmth, protection, oxygen, etc.). When they finish, tell the kids that special features of an organism that improve its chances of surviving are called **adaptations.** Write **adaptation** so that everyone can see it, and discuss its meaning.

WHAT TO DO NEXT

Adaptation–Predator-Prey
Attention!
Seed Dispersal
Invent an Animal
Invent a Plant

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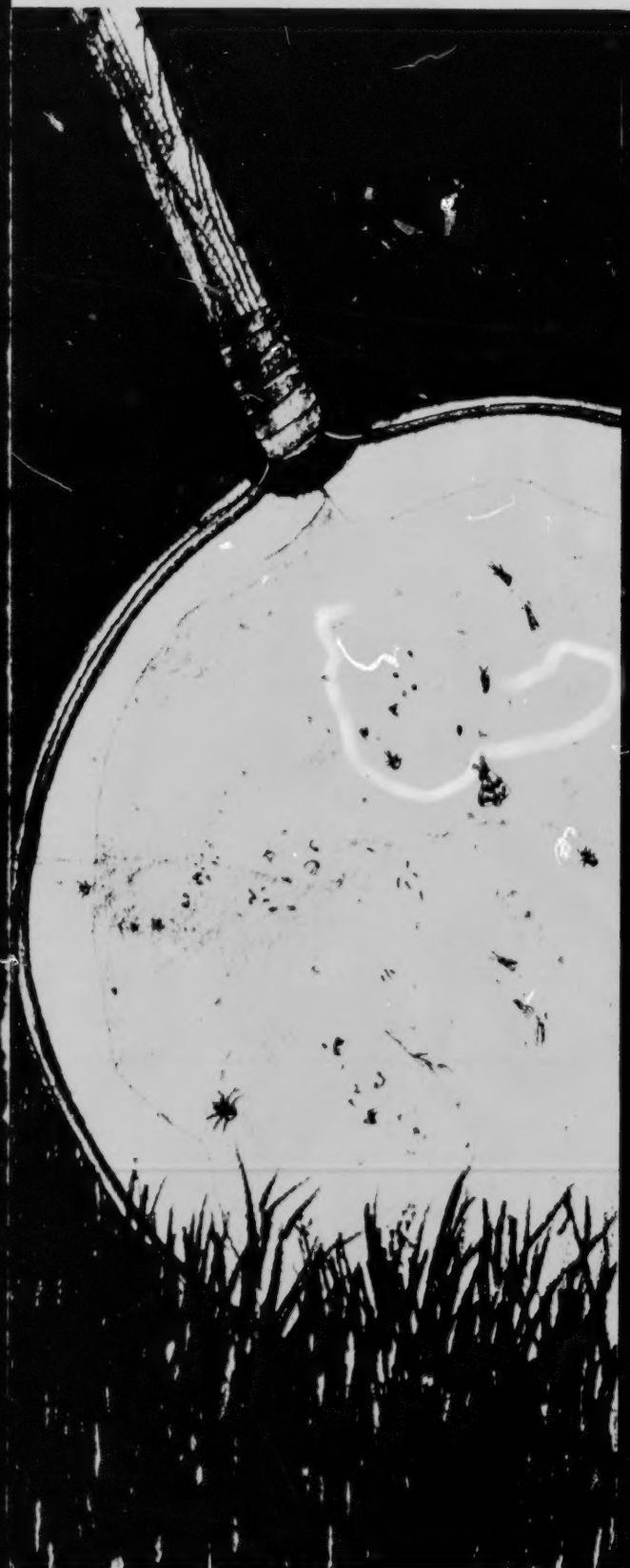

Lawns and other grasslands support many populations of small flying, hopping, and crawling animals. Because these animals are often well camouflaged, the casual observer usually fails to see them at all. A good tool for collecting hopping and flying lawn animals for observation is a sweepnet or butterfly net. Flies, moths, leaf hoppers, wasps, ladybugs, and gnats are a few of the animals often sampled with sweepnets. However, animals that walk along the ground are rarely collected with sweepnets; ants, beetles, isopods, spiders, millipedes, and tiny springtails can be sampled with small pitfall traps. Vials buried with the tops flush to the ground surface make fine traps, especially if they are baited with a variety of foods.

FIND AS MANY DIFFERENT KINDS OF ANIMALS ON A LAWN AS POSSIBLE.

The techniques outlined in this activity allow investigators to search out and observe some of the animals living in a lawn study site. Initially, youngsters will try to find animals without the aid of nets. Frequently this search is fruitless. If you then demonstrate the use of a sweepnet, you can dazzle your investigators with the number and variety of animals you can catch. Next, participants use the nets to sample the site and hold their catch in plastic bags for observation. A question and discussion session helps develop appreciation of the diversity of animal life, and it may lead to a follow-through investigation of animals that are caught in pitfall traps.

MATERIALS

For the group:

1 data board for listing animals caught
1 marking pen

For each team of two:

1 sweepnet (see "Sweepnet" equipment card in the *OBIS Toolbox* folio)
2 plastic bags
2 rubber bands
1 *Lawn Guide*

Materials for the follow through
For each team of two:

2 6cm. squares of aluminum foil (small jars or tin cans may be substituted)
1 trowel or dinner knife
Small pieces of bait such as peanut butter, lettuce, meat, bread, sugar, candy, hard egg, etc.

PREPARATION

Get the "Sweepnet" equipment card from the *OBIS Toolbox* folio. If you plan to make nets for your group, construct them in advance. If your participants are going to make their own nets, plan to devote an entire period for this activity, since it is time consuming.

Select a grassy area, preferably near some bushes.

If you intend to do the recommended follow-through section of this activity, don't forget to organize some baits for the fall traps. Only tiny pieces of bait are necessary, and a wide variety is best.

ANIMALS IN A GRASSLAND

ACTION

1. Present the challenge to the participants: "HOW MANY DIFFERENT KINDS OF ANIMALS CAN YOU FIND LIVING IN OUR STUDY SITE?"
2. Distribute a plastic bag to each of the youngsters and encourage them to search on "all fours." They probably will not have much success so interrupt them after five minutes and demonstrate how rapidly you can collect animals with your sweepnet.
3. Distribute a sweepnet to each team of two and let the teams collect. You should help those having trouble transferring animals from the nets to the plastic bags. (See the "Sweepnet" equipment card.) Let the participants continue to sweep and add samples to their observation bags for fifteen to twenty minutes. Encourage them to share discoveries they make while sweeping.
4. When sweeping is complete, gather the participants into a group and list the animals on the data board. Use names from guides or make up names for animals that can't be identified.
5. Remind the students to look for interactions in the bags. Are there any animals eating others? Is there water vapor in the bag? Is a spider spinning a web? Keep your eyes open.
6. Remember: return *all* animals to the grass when observations are complete.

WHAT DO YOU THINK?

- ☐ How many different animals did you find?
- ☐ What was the biggest animal you found? smallest?
- ☐ What kind did you find the most of? least?
- ☐ What colors? shapes?
- ☐ Do all of the animals you found have anything in common? What?
- ☐ Did you find more of one type of animal than of another? Can you think of any explanations?
- ☐ What interactions between two animals, or an animal and plant, did you see?
- ☐ Are there animals living in the lawn that are not easily caught by sweepnets? If so, how could they be captured?

FOLLOW THROUGH

A. In order to observe animals that are not usually caught in sweepnets, set up some small pitfall traps. If you have the opportunity of meeting with your group again in a day or a week, present this second challenge: "How many additional animals can we find that we didn't find with our nets?"

Follow Through Action:

1. Introduce the challenge.
2. Prepare a map of the study area on your data board. Investigators can mark on this map exactly where they put their traps. This will enable them to relocate the traps.
3. Show the group how to make and place pitfall traps.
   a. Place your thumb in the center of a square of aluminum foil and wrap the foil around your thumb to make an extra-long thimble. Punch a small pencil hole in the bottom of the foil thimble to allow water to drain. (Small jars or tin cans can be substituted for the foil traps.)
   b. Tell the participants to dig holes in the lawn the same size as the traps and to press the traps into the holes. Flare or flatten the foil sticking out of the hole so little animals can easily walk into the traps from the surrounding grassland.
   c. Drop a piece of bait into the the trap.
4. Distribute trowels, vials, and bait and have students set up pitfall traps.
5. Have each student record the exact location of his or her pitfall trap on the map.
6. Leave the traps in the lawn for at least eight hours before making observations.
7. When you return, have each student record on the map the kinds and numbers of animals in his or her trap.
8. Review the "What Do You Think?" questions.

B. Conduct a night sweepnetting activity. Compare the results of a night sweep to the results of a day sweep.

C. Observe the animals attracted to a light that is left burning at night in your study site.

D. Sweepnet a lawn immediately after mowing or watering. Make comparisons.

WHAT TO DO NEXT

Invent an Animal
Sticklers
Bean Bugs
What Lives Here?

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Some plants and animals are adapted to attract attention. Plants must attract animals for pollination and seed dispersal. Animals must attract members of their own kind for mating purposes and to warn others of danger. Many organisms use visual attraction by means of particular colors and patterns.

Often animals have particular behavioral adaptations which emphasize the color or pattern display. The white rump patch on American antelope, the white tail of cottontail rabbits, and the outer white tail feathers of some birds are all flashed into view when these animals are frightened.

Some organisms even attract the attention of their potential enemies. These organisms are usually distasteful, either because they give off smelly or bitter secretions, or because they have powerful stings. This type of **warning coloration** is demonstrated by skunks, with their obvious black and white bands, as well as bees and wasps, with their bright yellow and black stripes.

Some animals, like the Viceroy butterfly, have false warning coloration to protect themselves from being eaten by birds. The Viceroy butterfly mimics the appearance of the attractive Monarch butterfly which is distasteful to birds.

Attention-catching features such as color, sound, and smell are examples of adaptation. An **adaptation** is any special feature of an organism that improves its chances of surviving and reproducing.

Although we often think of colorful flowers and animals only in terms of beauty, attractive colors and designs in nature have specific purposes. In this activity, everyone creates, for a specific habitat, a design intended to attract another member of the group. When the designs are placed in the habitat, each participant tries to find the design created especially for him or her.

CREATE A DESIGN WHICH WILL ATTRACT ATTENTION IN A PARTICULAR HABITAT.

MATERIALS

For the group:
materials for coloring:
color crayons,
tempera paint,
felt-tipped pens, etc.

paper (small pieces of drawing paper)
string or wire to hang or attach designs
tape

Action Card Side 1
ATTENTION!

Name _____

Your favorite color is _____

Pick one of these patterns:

_____ checkered
_____ stripes
_____ rectangles
_____ spots
_____ diamonds
_____ triangles

Choose a habitat:

_____ grassy
_____ leafy
_____ rocky
_____ other

Action Card Side 1
ATTENTION!

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Name _____

Your favorite color is _____

Pick one of these patterns:

_____ checkered
_____ stripes
_____ rectangles
_____ spots
_____ diamonds
_____ triangles

Choose a habitat:

_____ grassy
_____ leafy
_____ rocky
_____ other

Action Card Side 1
ATTENTION!

Outdoor Biology
Instructional Strategies

Name _____

Your favorite color is _____

Pick one of these patterns:

_____ checkered
_____ stripes
_____ rectangles
_____ spots
_____ diamonds
_____ triangles

Choose a habitat:

_____ grassy
_____ leafy
_____ rocky
_____ other

Action Card Side 1
ATTENTION!

Outdoor Biology
Instructional Strategies

Name _____

Your favorite color is _____

Pick one of these patterns:

_____ checkered
_____ stripes
_____ rectangles
_____ spots
_____ diamonds
_____ triangles

Choose a habitat:

_____ grassy
_____ leafy
_____ rocky
_____ other

Action Card Side 2
ATTENTION!

Find a real plant or animal that attracted your attention by:

_____ smell

_____ sound

_____ sight

Do the features that caught your attention warn or attract?

23

Action Card Side 2
ATTENTION!

Outdoor Biology
Instructional Strategies

Find a real plant or animal that attracted your attention by:

_____ smell

_____ sound

_____ sight

Do the features that caught your attention warn or attract?

Action Card Side 2
ATTENTION!

Outdoor Biology
Instructional Strategies

Find a real plant or animal that attracted your attention by:

_____ smell

_____ sound

_____ sight

Do the features that caught your attention warn or attract?

26

Action Card Side 2
ATTENTION!

Outdoor Biology
Instructional Strategies

Find a real plant or animal that attracted your attention by:

_____ smell

_____ sound

_____ sight

Do the features that caught your attention warn or attract?

27

ATTENTION!

ACTION

1. Distribute an **Action Card** to each of the students. Ask them to fill in "Side 1" and to remember the information for use later in the activity.

Action Card — Side 1
Name _____
Your favorite color is _____
Pick one of these patterns:

checkered.	spots.
stripes	diamonds.
rectangles.	triangles.

Choose a habitat:

grassy.	leafy.
rocky.	other _____

2. Place **Action Cards** in a hat and have each person draw one. (Tell participants that if they get their own, to trade with someone.) DON'T TELL WHOSE CARD YOU HAVE.

3. Have the kids make a design that will attract attention in the habitat indicated on the card. Each child should use the pattern and color listed, and pick one other color of his own choice. Everyone should make his design as outstanding as possible, and, when finished, hang it somewhere in the habitat.

4. When everyone has finished, each person should try to find the design made for him or her.

5. After all have found their designs, have the group decide whose creation has the most attention-attracting characteristics.

6. Side 2 of the **Action Card** states: Find a real plant or animal that attracted your attention by:
smell _____
sound _____
sight _____
Do the features that caught your attention warn or attract?

WHAT DO YOU THINK?

1. Are there certain designs that attract attention in more than one habitat?
2. What would happen if a defenseless fly had the design and colors of a bee?
3. What would happen if all organisms were attracted to the same designs?
4. What kinds of sensory displays do humans use to attract attention?

FOLLOW UP

Not all animals have the same quality of vision. Some, with limited color vision, view the world in varying shades of a single tone. Provide the group with colored cellophane masks. The masks can be made by taping colored cellophane (red is an effective color) to the forehead, covering the eyes.

Have everyone search for the designs again, and compare the results of the two searches.

Note: Colored cellophane or gel may be purchased from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

WHAT TO DO NEXT

Invent an Animal
Seed Dispersal

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All plants and animals live with others of their kind in populations. Some populations are relatively small and you can census them by counting them. For instance, in a lawn there may be some elm trees which can be censused in a few seconds by counting. There are, however, populations that are relatively large and their number must be estimated, since counting them would take too long. The technique suggested here is called a quadrat technique and is appropriate for estimating populations of organisms that move very slowly, or not at all. A census of the grass plants in a lawn, or lady bugs in a meadow, could be conducted with a quadrat technique.

OUTLINE OF QUADRAT TECHNIQUE

If you can't count all the individuals of a population in a study area, you count all the individuals in a small area of the study site and multiply by the number of these small areas in the whole study area. This small area is called a quadrat. A convenient area for a quadrat might be a square meter, a square centimeter, or a square decimeter, depending on the size of the organism being censused. The square decimeter is a nice-sized quadrat for bean bugs. You may never have heard of a decimeter.

1 decimeter = 10 centimeters or $\frac{1}{10}$ meter

1 square decimeter = 100 square centimeters or $\frac{1}{100}$ square meter

Since the population may not be (and usually is not) uniformly distributed throughout the study area, you will want to take several samples, that is,

count the individuals in several different quadrats. These several quadrats should be randomly selected to avoid investigator biases. Wire quadrats are useful because they can be tossed into the study area (random samples) several times (multiple samples), and the results averaged. This average is the estimated number of organisms per quadrat. Now all you have to do is figure out the number of these quadrat-sized areas in your study area and multiply this number times the number of organisms per quadrat to arrive at an estimate of populations.

Example:

Your study area is 40 square meters.
your quadrat is 1 square decimeter.
You take 7 random samples. 8, 6, 12, 3, 0, 16, 11
Add these samples 8 + 6 + 12 + 3 + 0 + 16 + 11 = 56
Average these samples 56 divided by 7 = 8 organisms per quadrat.
Since there are 100 square decimeters in a square meter, and there are 40 square meters in your study area, you multiply 100 x 40 to get the number of quadrats in the study area. 4,000.
At 8 individuals per quadrat, you multiply 8 x 4000 = 32,000 organisms in the population.

ESTIMATE THE NUMBER OF INDIVIDUALS IN A POPULATION TOO NUMEROUS TO COUNT.

Bean bugs (mung beans, split peas, lentils, etc.) are make-believe animals which you can introduce into your study site for the purpose of using the quadrat technique for estimating populations. We suggest bean bugs rather than one of the populations living in your study site because you can control the population; you know how many bean bugs you put into the study site. Once your investigators have completed their estimates, the population can be verified by comparing results against the known population size. If the investigators get results that are reasonably close, they will feel confident using the technique in the field. To emphasize the usefulness of the technique, it is recommended that you follow through with some censuses of plants and animals living in your study site.

MATERIALS

For the group:

1 data board
1 marking pen
1 lb. bean bugs
2 meter sticks
1 ball of string
4 nails

For each investigator:

1 wire quadrat 10 cm. x 10 cm. square
1 paper and pencil

BEAN BUGS

Quadrat Census Technique

PREPARATION

Before meeting with your group, determine the population size of bean bugs you are going to introduce into your study site. In other words, you will have to figure out how many beans are in the bag. Unless you want to count them all, you will have to estimate the number yourself, either by weight or volume. If you have an accurate scale, weigh an ounce of beans, count them, and multiply by 16 (if you have a pound of beans!). If you don't have a scale, try a measuring cup. See how many ounces (measuring cup ounces) of bean bugs you have. Then count a tablespoon full of bean bugs and multiply: two tablespoons = 1 ounce; 8 ounces = 1 cup. That is all the advance preparation necessary, but keep in mind that, before starting the activity with your group, you will want to designate a portion of your study area as the bean bug study area. It should be about 35 square meters and outlined with string.

ACTION

First, you will want to measure off a section of your lawn as the bean bug study area. An area about 35 to 50 square meters is about right for a pound of bean bugs. Have several volunteers measure off the area and mark it with string, using a ball of string and nails. This will require some time and the students may want help from others in the class.

Presenting the Problem:
When the bean bug area is ready, tell the group, "I have here a population of bean bugs. I am going to introduce them into the lawn in this bean bug area." Walk around inside the roped-off area and distribute bean bugs evenly throughout the area. Then say, "We now have a population of bean bugs living in your lawn. Does anybody have an idea how we could find out how many bean bugs there are in the population?" Entertain some suggestions; focus attention on ideas that contribute to a quadrat estimate technique, like "We can count the bean bugs in a little area, maybe a square meter, and then multiply by the number of square meters in the whole study area." Lead the discussion to an outline of the technique, then say, "The technique you have outlined is called a quadrat estimate technique." Tell them that a good quadrat has these qualities:

1. Several random samples; the more the merrier, and random is the rule. (They should throw one-decimeter square wires in the air and let them fall.)
2. Average the sample (8 + 6 + 12 + 3 + 0 + 16 + 11) divided by 7 = 8.
3. Multiply the average by the total square decimeters in the bean bug area.

You might want to outline these three points on the data board. Quadrat squares and tape measures are provided to help them with their estimates. Tell them that you know how many bean bugs there are on the lawn. Then let them try the quadrat technique to see if it works. Have everyone do his own estimate and tell you when he is finished.

WHAT DO YOU THINK?

When everyone has completed an estimate, record the results on the data board. Reveal your "accurate" estimate at this point. Estimates can be expected to vary over a wide range. Discuss the range and ask them what might be responsible for the range. Some of these are:

samples not random

incomplete counts of bean bugs in the sample area; they can be hard to see

too few samples

arithmetic errors

non-uniform distribution of the bean bugs.

Ask one of the students to average all the estimates made by the investigators and compare that estimate with the estimate you determined in advance. Is it close? Closer than any of the individual estimates? Why?

FOLLOW THROUGH

☐ Redo the activity to census some of the living organisms in your study site. Remember to calculate the area of your study area carefully.

☐ Are there worms on the lawn? Estimate the population of a species of worm.

☐ Here is an arithmetic problem: How big would a single leaf be that was equal to the total leaf area of the grass in the lawn? Compare this with the size of the leaf equal to the total broadleaf area on the lawn.

☐ Look at the soil in the lawn. Examine a cubic decimeter section. Count one type of soil organism, and estimate the population size of the organism in a 50 square meter/1 decimeter deep plot.

☐ Estimate the number of grass plants growing on a lawn.

☐ Estimate the number of trees in an orchard or woodlot (without counting them all).

WHAT TO DO NEXT

Sticklers
How Many Organisms Live Here?

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Currents in a Stream

FINISH

A stream is a mass of water that carries sediment as it moves between banks, following the course of least resistance toward a lower elevation. The stream bottom may be rocky, muddy, or sandy. Rocky bottoms are usually found where the stream runs rapidly over a steep gradient.

Sandy and muddy bottoms may be found occasionally in pools of fast-flowing streams, but more often are in slow-moving, wide, and deep streams.

You may investigate the flow in any stream, but one that has some turbulence will produce more exciting results. Turbulence occurs when moving water meets obstacles which alter the course of the flow.

ENTER THE GREAT STREAMBOAT RACE AND DISCOVER THE RATE AND DIRECTION OF CURRENTS IN A STREAM.

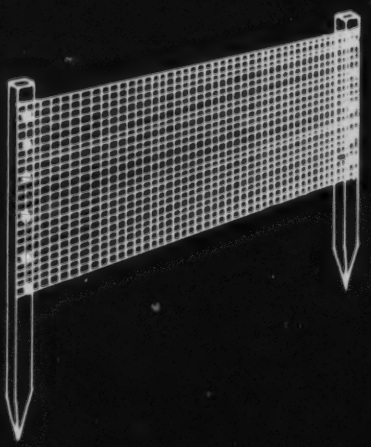
MATERIALS

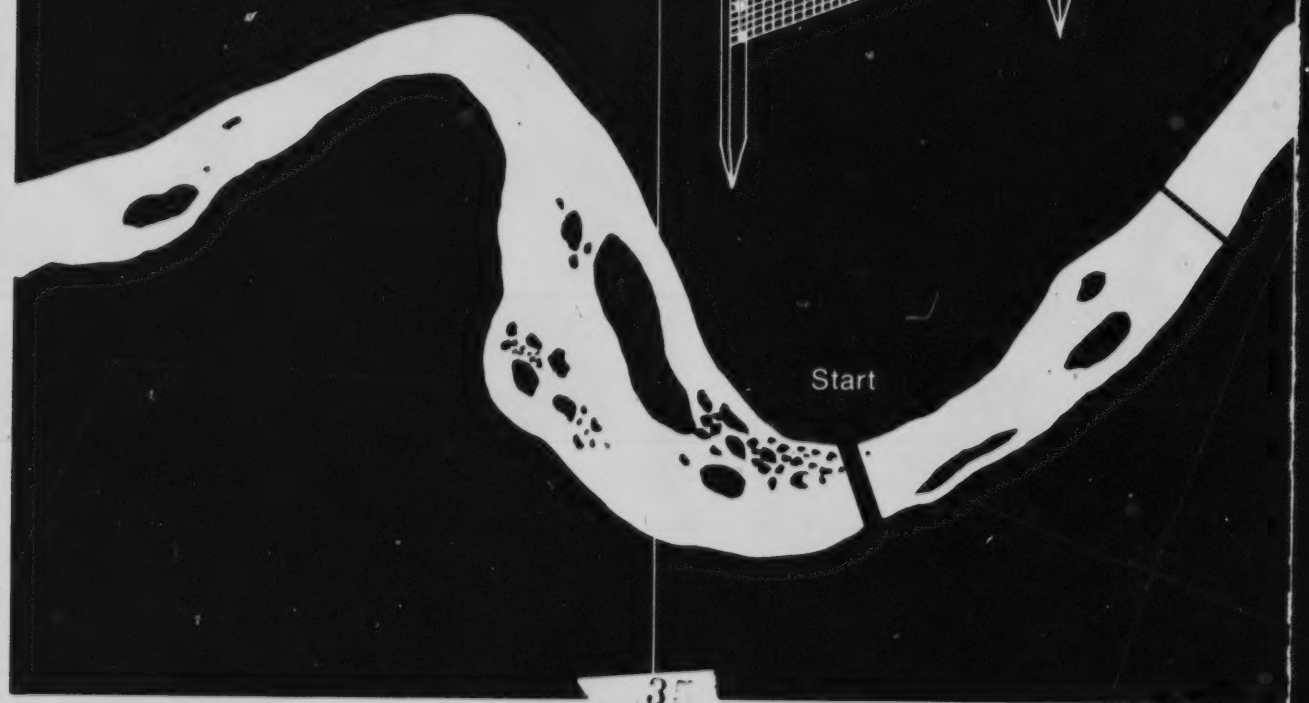
For the race:
cork slices (boats)
window screen
marking pen
tacks
2 poles

For the speed check:
one-meter long sticks
cork slices
string
stopwatch or watch with a second hand
drawing paper
pencil

PREPARATION

Choose a turbulent stream site that is shallow and narrow enough for students to investigate all parts.
Make cork boats by slicing corks into three disk-shaped pieces.
Make a flow meter:
To one end of a one-meter long stick, tie a string that extends one meter from the stick's tip. Fasten a cork to the free end of the string.
Make a hand screen:
Tack a fine-mesh window screen onto two poles to make a hand screen for collecting the cork boats. The width of the screen should be as wide as the stream.



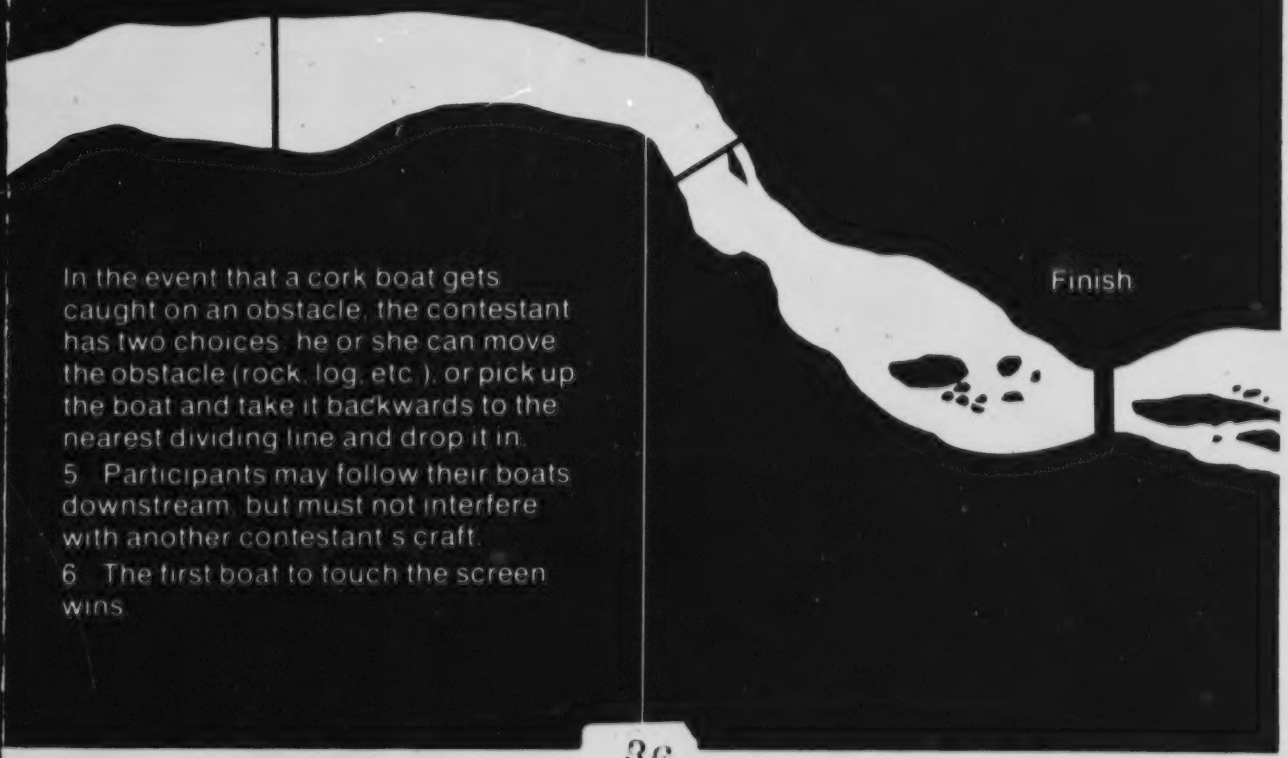


GREAT STREAMBOAT RACE

RULES FOR THE RACE

The purpose of this activity is to investigate the effects of obstacles on the flow of the stream. For best results, establish a set of race rules with the participants, and penalize or temporarily disqualify any rule-breaker.

1. Each boat must be a slice of cork marked with the owner's initials.
2. The finish line is a hand screen held in place by participants (or rocks conveniently located) ten to twenty meters below the starting line. The main current of the stream must flow through the screen.
3. The Race Official (leader or designated student) releases all boats at the same time from the starting line.
4. The race course is marked off in four equal parts.



In the event that a cork boat gets caught on an obstacle, the contestant has two choices: he or she can move the obstacle (rock, log, etc.), or pick up the boat and take it backwards to the nearest dividing line and drop it in.

5. Participants may follow their boats downstream, but must not interfere with another contestant's craft.
6. The first boat to touch the screen wins.

RACE RESULTS

What causes some boats to go more slowly than others?

What causes some boats to get caught in places where they are not touching solid obstacles?

What evidence suggests that there are currents of different speed and direction in the stream?

SPEED CHECK

This post-race activity allows contestants to investigate the rate of flow in different parts of the stream.

1. Divide the participants into two-member teams: one will be a flow-meter operator and the other a timer.
2. Provide each team with a flow meter and a stopwatch or other timing device.
3. Have each team mark off an area of investigation (three or four meters of stream).
4. Give instructions for use of the flow meter: the operator stands near the section of stream or current to be measured. At the timer's signal, the cork is dropped into the water. When the string tightens, the operator yells "Stop!" and the timer records the time in seconds per meter. During each trial, the tied end of the stick should be held as close as possible to the point where the cork was first dropped.
6. Ask the participants to locate and record the fastest and slowest currents in their sections of the stream.
7. Have them identify the physical conditions associated with the swiftest and slowest current areas.
8. When the teams have finished, gather the group together and compare results.

WHAT TO DO NEXT

Aquatic Hi-Lo Hunt
Terrestrial Hi-Lo Hunt

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Berkeley California

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Each plant and animal lives in its home or **habitat**.

in trees . . .

under rocks . . .

Sunlight is one of the environmental factors in most habitats. You can use sunlight to make a record of almost any object in a place where plants and animals live. This place, where an organism usually lives and where you would most likely find it, is called a **habitat**.

A sun print, or photogram, is a good technique for observing the objects in a habitat. Sun prints are photographs made without camera or darkroom, and they provide outdoor groups with an interesting method of recording evidence of plants and animals in their natural environments. It's fun and easy to make sun prints — try it!

in the water

MAKE A SUN PRINT OF ORGANISMS AND OBJECTS REPRESENTATIVE OF A PARTICULAR HABITAT.

PREPARATION

- This activity must be done on a sunny day.
- Prepare some sun prints as examples for the group.

MATERIALS (Select A or B)

A. OZALID PAPER METHOD

For the group:

1 large data board or other display board or space
1 roll of tape
2 or 3 wide-mouth, gallon jars of plastic or glass *with tops*
3-4 cups of gravel or sand
1 grocery bag for each one-gallon container
1 plate of glass or piece of plastic food wrap
1 pint of household ammonia

For each student:

Ozalid paper in light-proof envelopes (allow 1 or 2 pieces per student)
15 cm. by 20 cm. is a good size

B. BLUE PRINT PAPER METHOD

For the group:

1 large data board or other display board or space
1 roll of tape
2 or 3 tubs of water
few drops of hydrogen peroxide

For each student:

1 or 2 pieces blueprint paper
1 plate of glass or transparent plastic, or sheet of saran wrap, if working in a wet habitat.

Note: Ozalid and blueprint paper may be obtained from engineering supply houses or from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

Action Card
HABITAT SUN PRINTS

Make a sun print of a tree habitat. Try to include at least 3 things — plants, animals, and non-living objects.

Action Card
HABITAT SUN PRINTS

Make a sun print of a water habitat. Try to include at least 3 things — plants, animals, and non-living objects.

Action Card
HABITAT SUN PRINTS

Make a sun print of an under-rock habitat. Try to include at least 3 things — plants, animals, and non-living objects.

Action Card
HABITAT SUN PRINTS

Make a sun print representing a shrub habitat. Try to include at least 3 things — plants, animals, and non-living objects.

Technique Card
HABITAT SUN PRINTS

Outdoor Biology Instructional Strategies

How to use paper:

1. Gather items for your sun print.
2. In your shadow (with your back to the sun), arrange items on the paper. Cover with clear plastic.
3. Step aside and let sun shine on the paper for 40-60 seconds.
4. Develop paper for 60 seconds in . . .

(For Ozalid paper)

(For Blueprint paper)

5. Let paper dry in the shade.

Technique Card
HABITAT SUN PRINTS

Outdoor Biology Instructional Strategies

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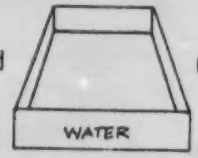

(For Blueprint paper)

5. Let paper dry in the shade.

Technique Card
HABITAT SUN PRINTS

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(For Ozalid paper)

(For Blueprint paper)

5. Let paper dry in the shade.

HABITAT SUN PRINTS

HOW TO MAKE A SUN PRINT

A. Ozalid Paper Method

1. Pour enough household ammonia into each one-gallon jar to cover the bottom.
2. Pour 2 cups of sand or gravel into the jar and mix with the ammonia. There should be enough gravel to prevent the ozalid paper from touching the ammonia.
3. Set each jar in a grocery bag to prevent strong light from penetrating the jar.
4. In the shade of your body, remove one sheet of Ozalid paper and arrange organisms and objects on the paper. Covering the objects with a clear plate or plastic food wrap will hold the objects flat against the Ozalid paper.
5. Step aside and expose the paper to direct sunlight for 30-60 seconds.
6. Pick up the paper and quickly put it into the jar. Put the cover on the jar and allow the paper to develop until the image appears.
7. If the ozalid prints take too long to develop or appear too weak, shake up the gravel in the jar to reactivate the fumes. If this doesn t help, add more ammonia.

B. Blue Print Paper Method

1. Put a few drops of hydrogen peroxide in each tub of water.
2. In the shade of your body, place items on the blueprint paper. If the items are wet, place a clear glass plate or plastic food wrap over the blueprint paper so it will not be ruined, then place the items on top of the plate or plastic.
3. When all is arranged, step aside and allow the sunlight to expose the paper for 40-60 seconds.
4. Plunge the exposed blueprint paper in the tub of water for one minute, at least, moving it around a little.
5. Remove from water. Allow to dry in shade.

ACTION

1. Demonstrate the sun print technique to your group.
2. Introduce the challenge and distribute the Action Cards.
   - ☐ Make a sun print representing a grassy habitat. Try to include at least 3 things — plants, animals, and non-living objects.
   - ☐ Make a sun print representing a soil habitat. Try to include at least 3 things — plants, animals, and non-living objects.
   - ☐ Make a sun print representing natural ground litter. Try to include at least 3 things — plants, animals and non-living objects.
   - ☐ Make a sun print representing a paved habitat. Try to include at least 3 things — plants, animals, and non-living objects.
   - ☐ Make a sun print of an under-rock habitat. Try to include at least 3 things — plants, animals, and non-living objects.
   - ☐ Make a sun print representing a shrub habitat. Try to include at least 3 things — plants, animals, and non-living objects.
   - ☐ Make a sun print of a tree habitat. Try to include at least 3 things — plants, animals, and non-living objects.

- ☐ Make a sun print of a water habitat. Try to include at least 3 things — plants, animals, and non-living objects.

3. Make a collage of the sun prints. Each student can then describe a habitat in terms of his or her sun print. The combination, or collage, of sun prints represents a series of habitats for this study area.

WHAT DO YOU THINK?

- ☐ Were there parts of the habitat not represented by your sun print? If so, what are they?
- ☐ Does your collage include all of the habitats in your study area? If not, why are some of the habitats not represented?
- ☐ Think of ways to represent organisms in the study area that cannot be sun-printed.

FOLLOW THROUGH

Individuals can produce other sun prints using only non-living objects. They then can try to predict the types of organisms (plants and animals) that would live in the habitat.

Make a sun print of a habitat for an imaginary organism — an **Okpok. Okpoks** require warm, moist, dark places to live and they eat plants.

WHAT TO DO NEXT

Habitats of the Pond
Invent an Animal

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Lawrence Hall of Science
University of California
Berkeley California

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A pond is a body of standing water so shallow that rooted plants grow over the entire bottom. A lake is usually larger than a pond, and the water is too deep for plants to grow, except around the shore. In and around both lakes and ponds, you can easily recognize five distinct areas: the surface film, the open water, the bottom, the water's edge, and the air above the pond. These five distinct areas are called habitats. A **habitat** is the place where an organism normally lives and where you would ordinarily go to find it.

Surface film is the habitat for certain beetles, water bugs, and free-floating plants that live on the upper side of the film.

Open water is the area in the center of a pond where rooted plants do not extend to the surface of the water. Some of the organisms that live in open water are fish, turtles, birds, and large and small plants.

The bottom is inhabited by a variety of animals including snails, flatworms, earthworms, sponges, crayfish, and the nymphs of mayflies, dragonflies and damselflies.

The water's edge is where water meets the land. For the purposes of this activity, this area is defined as approximately 10 centimeters into the water and 10 centimeters onto the land encircling a pond or lake.

The air over the water contains flying insects, birds, bats, wind-blown seeds, weeds, reeds, etc.

LOCATE PLANTS AND ANIMALS IN EACH OF THE FIVE HABITATS OF A POND OR LAKE, AND RECORD WHERE THEY LIVE.

In this activity, teams hunt for organisms in different areas of a pond, using plankton nets, bottom scrapers, and weed grapples. The teams then map the location of each organism. After the investigation, the term **habitat** is introduced.

MATERIALS

For the group:
cross-sectional map of pond
felt-tip markers (brown, blue, green, red)

Observation Tools
1 weed grapple
1 plankton net
1 bottom scraper

1 sieve (kitchen strainer or piece of nylon stocking)

Each team should have at least one of these three pieces of equipment. See equipment cards in the *OBIS Toolbox* folio for instructions on construction and use.

For each buddy team of two:
1 *Pond Guide*
site markers
2 dip nets
2 Bug Boxes or magnifying lenses
1 white-bottomed container

Note: Certain hard-to-get items such as Bug Boxes and magnifying lenses are available from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

HABITATS OF THE POND

PREPARATION

A good activity to precede this one is *What Lives Here?*

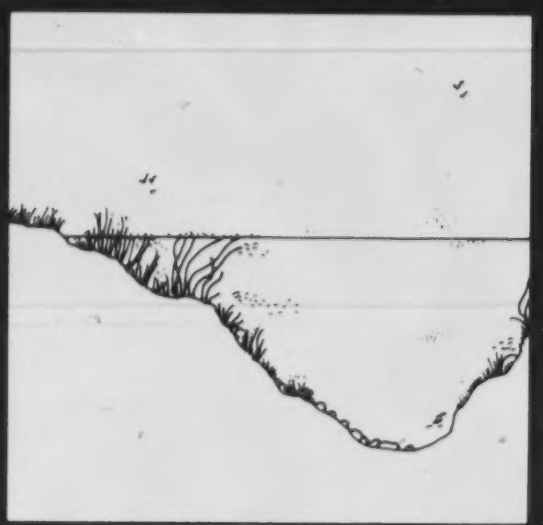
Cross-sectional map

Draw a cross-sectional map (like the one below) of the pond or lake on a piece of poster board. Use blue felt pen for the surface of the water, and brown for the bottom.

Equipment preparation

This may be done as a group activity (see equipment cards in the *OBIS Toolbox* folio).

- Plankton Net
- Bottom Scraper I and II
- Weed Grapple
- Basic Aquatic Equipment



ACTION

1. Display the cross-sectional map and point out the parts that represent:
   A. Water's edge
   B. Bottom
   C. Open Water
   D. Surface
   E. Air over pond or lake
2. Demonstrate the use of each piece of equipment and distribute a different piece of equipment to each team. (If you have four or more teams, you may want to make more than one of each of the observation tools.)
3. Tell the students to search all the habitats of the pond for as many different plants and animals as they can find. In order to search all habitats, the teams will have to exchange their specialized pieces of equipment.
4. Ask the students to record the name of each located organism on the appropriate part of the map.
5. After the students have completed observing and recording, have them return all organisms to the areas where they found them.

WHAT DO YOU THINK?

☐ Are there any plants or animals found in only one area?

☐ Are there any plants or animals that live in more than one area?

☐ After it becomes apparent that there are different organisms in different areas, tell the students that each area represents a particular habitat. Explain that the **habitat** for any organism (plant or animal) is the place where an organism normally lives and where you would ordinarily go to find it.

☐ Were there organisms you saw but were not able to collect? Add these to your map.

FOLLOW THROUGH

☐ If microscopes or bioscopes are available, collect water and bottom mud and examine them.

☐ Teams can chart the number of organisms in each of the five habitats to see which supports the most life.

☐ Have each student or team investigate a different habitat, using the appropriate piece of equipment to find a plant and an animal not represented on the map.

WHAT TO DO NEXT

How Many Organisms Live Here?
Animal Movement in Water
Habitat Sun Prints
Animals in a Grassland

Outdoor Biology Instructional Strategies
Lawrence Hall of Science
University of California
Berkeley California

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Have you ever wondered how many organisms live on the bottom of a pond? Or how to find out what lives down there?
Scrape the bottom
strain the scrapings
and see what you find!
Most of the organisms that you find will belong to a population. A **population** is a group of organisms of the same kind that lives and reproduces in a particular area.

FIND OUT HOW MANY ORGANISMS LIVE IN ONE SQUARE UNIT OF POND BOTTOM.

In this activity your group takes a census of pond bottom organisms. The census is made by using a bottom scraper to scrape a square unit, approximately 25 cm on a side, of pond bottom to a depth of 3 cm. The square should be near enough to shore to be easily scraped. Strainers and pieces of mesh are then used to locate and count organisms.

MATERIALS

For the group:
Census chart
red and green marking pens
meter tapes or sticks

For each team:
1 *Pond Guide* for identification of organisms
1 magnifying lens
1 kitchen strainer
1 piece of fine mesh
site markers
bottom scraper
white-bottomed container
team census chart
pencils

Note: Certain hard-to-get items such as meter tapes and magnifying lenses are available from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

PREPARATION

Make a large version of the Census Chart that is inserted in this folder. Make small copies for each team. Sample Census Chart*

List the number of organisms found by each team.		Team 1
ANIMALS	Tubifex Worms	
	Snails	
	Clams	
	Damselfly Nymphs	
	Scuds	
PLANTS	Elodea	
	Cattails	
	Pond Lilies	

*These organisms listed are examples of what you might find. For your chart list the organisms that you find at your site.

Provide a red marking pen for listing on the large chart the animal census results, and a green pen for the plant census results. Provide pencils for the teams to keep records on their team charts.

Cut pieces of discarded nylon pantyhose or stockings to be used as fine-mesh strainers. You may wish to make the bottom scrapers yourself, or make the construction part of the group activity.

CENSUS CHART

HOW MANY ORGANISMS LIVE HERE?

Outdoor Biology Instructional Strategies

	List the number of organisms found by each team	Team 1	Team 2	Team 3	Team 4
ANIMALS					
PLANTS					

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HOW MANY ORGANISMS LIVE HERE?

ACTION

1. Ask the group, How many organisms do you think live in one square, 25 cm, on a side, of pond bottom? Encourage participants to make estimations.

2. Divide the group into teams of two. Suggest that they use the following procedures.

A. Use a bottom scraper to scrape one square, 25 cm, on a side, of near-shore bottom to a depth of 3 cm. Meter sticks are available for measuring.

B. Place the scrapings in a white-bottomed container, taking care not to lose any of the scrapings. Observe immediately, and count the organisms. Magnifying lenses will help.

C. Count the plants, and then carefully check for any organisms that might live on the plants. Also check rocks and sticks carefully. Rinse plants and rocks by placing them in a kitchen strainer and carefully run water over them until they are clean. Count the stranded organisms. Runoff water can be checked for organisms by pouring it through fine mesh before returning the water to the pond.

D. Immerse plants, rocks, logs, other debris, and the strainer in water after they are checked for organisms. Some organisms (hydra for example) are easily overlooked until the object they are attached to is immersed in water and left undisturbed for a few minutes.

Get the Bottom Scraper and Basic Aquatic Equipment cards from the *OBIS Toolbox* folio.

Team 2	Team 3	Team 4

3. After you are certain the teams understand the instructions, let them work on their own. Each team should make at least one census. If enough time is available, ask each team to make two censuses. All organisms should be returned to the pond after they have been counted. Let the teams work until fifteen minutes remain in the session.

WHAT DO YOU THINK?

When all of the censuses have been recorded, ask which team found the greatest number of organisms, and which found the greatest number of different kinds of organisms. Write the term **populations** in large letters at the top of the chart. Explain that a population is a group of organisms of the same kind that lives and reproduces in a particular area.
Now compare the different censuses and ask why each team didn't find the same numbers and kinds of organisms. If they took two censuses, ask them if they can explain any discrepancies between their first and second census.
Some possible explanations are:
inconsistent counting techniques
inadequate equipment
uneven distribution of organisms over a habitat
differences in area sampled

FOLLOW THROUGH

Using all the censuses taken, how might the group make an estimation of the number of organisms living on the entire pond bottom?
For reinforcement, ask the group to determine the population of highly visible surface organisms, e.g., shore plants, water striders, frogs, or ducks.

WHAT TO DO NEXT

Bean Bugs
Habitats of the Pond
Water Holes to Mini-Ponds
Sticklers

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Berkeley California

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Animals face the constant danger of being eaten. Many animals have markings and colorations on their skin or coat that blend into their habitats. This feature enables the animals to be camouflaged and hidden from a predator s view.

Some animals have a form that is similar in shape to objects in their habitat. This camouflages them from predators.

Camouflage is one type of animal adaptation. An **adaptation** is any special feature of an organism that improves its chances of surviving and reproducing.

INVENT AN IMAGINARY ANIMAL THAT IS CAMOUFLAGED FROM ITS ENEMIES BY BLENDING INTO ITS HABITAT. MAKE A MODEL OF THE ANIMAL.

MATERIALS

For the group:
potatoes
stringbeans
carrots
white latex paint
popsicle sticks
cotton
glue
toothpicks
plasticene or clay
tempera paint
paint brushes
masking tape
colored cellophane or gel (for follow-up activity)

PREPARATION

Paint the vegetables with white latex paint. This will make them conspicuous in almost any natural habitat, and camouflaging them will be a definite challenge.

Select two or more different sites as habitats for the "animals." The sites should be far enough apart so participants at one site cannot see where "animals" are located at another site.

INVENT AN ANIMAL-ADAPTATION

ACTION

1. Introduce the challenge: make an "animal" from your white-colored vegetable that blends into, or is hidden by, the natural surroundings. The vegetable is used as the main body-part of the animal. Emphasize that first each participant should choose a particular habitat (grassy, leafy, etc.) and then use the materials to fit the vegetable to the habitat. Both color and shape should be considered.
2. Divide the group into two or more teams and send each team to a separate site. After choosing a particular habitat in the site, each participant constructs an "animal" to place in that spot.
3. When all have finished (after thirty minutes or so), have the teams exchange sites and search for the camouflaged "animals."
4. Bring the recovered animals together for display. Those not found are more successfully camouflaged. Ask the inventors of the undiscovered "animals" to point out their obviously well-camouflaged creations to the hunters.

WHAT DO YOU THINK?

1. Why were some animals found and some not?
2. In what other habitats would your animal be well-camouflaged?
3. Name some animals you know that are protected by camouflage. Describe some you have seen.
4. Name some animals that are not protected by camouflage. How do they protect themselves from predators?

FOLLOW UP

Not all animals have the same quality of vision. Some, with limited color vision, view the world in varying shades of a single tone. Provide colored cellophane masks. The masks can be made by taping colored cellophane (red is an effective color) to the forehead, covering the eyes with the cellophane. Have the group "hide and search" for some of the model animals again. Compare the results of the two different searches.

Note: Colored cellophane or gel may be purchased from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

WHAT TO DO NEXT

Attention!
Animals in a Grassland
Invent a Plant
Sticklers

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Most animals can move to a new location when wind, water, heat, cold, sunlight, dryness, or other animals become a problem. Although plants cannot move to avoid unfavorable conditions, certain characteristics compensate for immobility, allowing them to live and reproduce in particular environments.

The special characteristics that allow plants to survive in specific environments are examples of adaptation. An **adaptation** is any special feature of an organism that improves its chances of surviving and reproducing.

This activity will enable participants to recognize that plants, as well as animals, are uniquely suited to their habitats. Using imagination and some craft materials, youngsters construct models of plants that are "adapted" to survive under specified environmental conditions.

CONSTRUCT A MODEL OF A PLANT THAT IS ADAPTED TO A PARTICULAR HABITAT.

MATERIALS*

Liquid plastic film such as Fantasy Film, Fun Film, Form-A-Film, etc. (or cellophane, plasticene, or any material for constructing models of plants)
roll of floral tape
scissors
wire (thin aluminum works well)
small styrofoam, clay, or egg carton base to support wire frames while plastic is drying

*You can obtain these materials at craft or hobby shops.

Action Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

Invent a plant which is lawnmower-proof.

Action Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

Invent a plant that can live on the surface of a pond.

Action Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

Invent a plant so it can withstand high winds.

Action Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

Invent a plant that grazing animals would not eat.

Technique Card
INVENT A PLANT

How to use plastic film:

A. Form the wire into a basic petal or leaf shape and contour it as you desire.
B. Dip the shaped wire into the plastic film.
C. Stand wire in styrofoam or clay to dry.
D. Group petals together into flower or plant form.
E. Wrap stems with floral tape.
F. Add plastic leaves to stem as you wrap it.

Technique Card
INVENT A PLANT

Outdoor Biology
Instructional Strategies

How to use plastic film:

A. Form the wire into a basic petal or leaf shape and contour it as you desire.
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Technique Card
INVENT A PLANT

Outdoor Biology
Instructional Strategies

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Technique Card
INVENT A PLANT

Outdoor Biology
Instructional Strategies

How to use plastic film:

A. Form the wire into a basic petal or leaf shape and contour it as you desire.
B. Dip the shaped wire into the plastic film.
C. Stand wire in styrofoam or clay to dry.
D. Group petals together into flower or plant form.
E. Wrap stems with floral tape.
F. Add plastic leaves to stem as you wrap it.

Action Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

Invent a plant that can hold on to rocks in swift rivers and streams.

Action Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

Invent a plant to catch insects.

Action Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

Invent a plant adapted to store water.

Action Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

Invent a plant that can compete with other plants for sunlight.

Technique Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

How to use plastic film:

A. Form the wire into a basic petal or leaf shape and contour it as you desire.
B. Dip the shaped wire into the plastic film.
C. Stand wire in styrofoam or clay to dry.
D. Group petals together into flower or plant form.
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F. Add plastic leaves to stem as you wrap it.

Technique Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

How to use plastic film:

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C. Stand wire in styrofoam or clay to dry.
D. Group petals together into flower or plant form.
E. Wrap stems with floral tape.
F. Add plastic leaves to stem as you wrap it.

Technique Card
INVENT A PLANT

Outdoor Biology Instructional Strategies

How to use plastic film:

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B. Dip the shaped wire into the plastic film.
C. Stand wire in styrofoam or clay to dry.
D. Group petals together into flower or plant form.
E. Wrap stems with floral tape.
F. Add plastic leaves to stem as you wrap it.

INVENT A PLANT - ADAPTATION

ACTION

1. Distribute the **Action Cards**. Each card has a different problem for the participants to solve. If the children have difficulty inventing, encourage them to observe some of the real plants in the area.

Invent a plant which is lawnmower-proof.

Invent a plant that can live on the surface of a pond.

Invent a plant so it can withstand high winds.

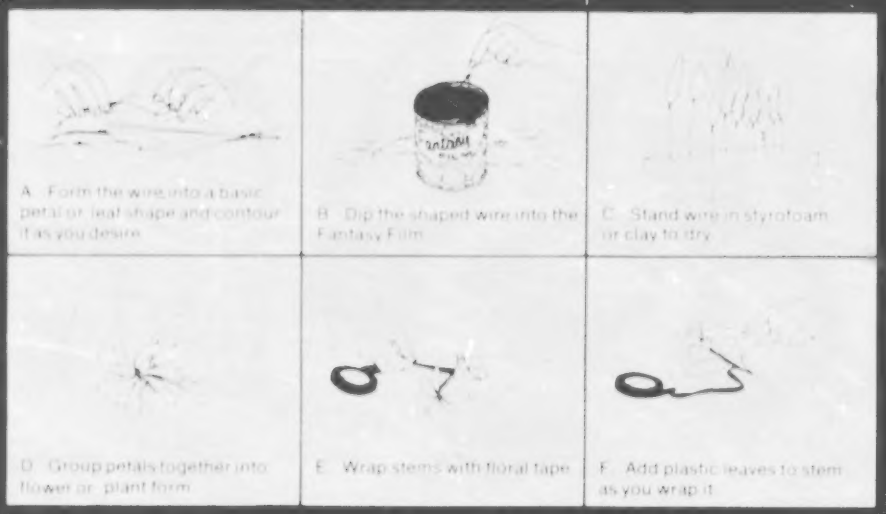
Invent a plant that grazing animals would not eat.

Invent a plant that can hold on to rocks in swift rivers and streams.

Invent a plant to catch insects.

Invent a plant adapted to store water.

Invent a plant that can compete with other plants for sunlight.


A. Form the wire into a basic petal or leaf shape and contour it as you desire.
B. Dip the shaped wire into the Fantasy Film.
C. Stand wire in styrofoam or clay to dry.
D. Group petals together into flower or plant form.
E. Wrap stems with floral tape.
F. Add plastic leaves to stem as you wrap it.

2. The preceding directions explain how to use the plastic film. (These instructions also appear on the back of each **Action Card**.)

Caution: Work in an open area to prevent inhalation of the plastic-film vapors.

3. When everyone has finished making a model plant, gather the group together. Have participants make inferences about the probable habitat and unique features of each plant.

WHAT DO YOU THINK?

Decide where each plant would be best suited to survive.

How would each plant be unsuited for different habitats?

How are plants adapted to seasonal changes?

FOLLOW THROUGH

Find real plants that have the same adaptations that the models have.

WHAT TO DO NEXT

Habitat Sun Prints
Seed Dispersal
Plants Around a Building

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Before having the children delve into the specific mysteries of a selected study site, it is often a good idea for them to become familiar with the site as a whole. Mapping a site is one way to "get the lay of the land," or identify the major features of that site.

THE ACTIVITY AT A GLANCE

Your group will be divided into teams of two to four and each team will be responsible for a section of the study site. Each team will use colored labels to map the features of its section of the outdoor site. After mapping, the teams place their section maps together to form one large map of the outdoor site. With the complete map before them, the teams discuss and choose names for the distinctive features of the site.

MAP THE MAJOR FEATURES OF AN OUTDOOR SITE.

MATERIALS

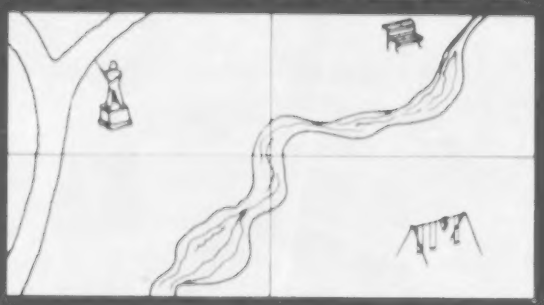
For the group:
1 data board
1 bag of eight different-colored tags, tapes, contact paper, or paper dots
1 marking pen

For each team:
1 data board with a section of the overview map on it
1 bag of eight different sets of colored tags (each team will need approximately 30 of each color)
1 marking pen

PREPARATION

1. Before the activity, the leader should obtain permission to use the site and become familiar with its landmarks.
2. The large overview map can be prepared ahead of time or can become part of the **ACTION** with the group's participation.
3. The size of the activity area will depend on the number of teams mapping. As a general guide, each team should have an area 10-20 meters square to map.
4. For each team's data board you will need a piece of thick cardboard or some similar material for backing. A good size is 80 cm. by 60 cm.
5. Using some sheets of butcher paper the same size as the backing, staple, clip, or thumbtack one sheet to each board.
6. Lay all the team data boards together and, using this enlarged space, draw a large overview map of some of the physical features (e.g. streams, roads, buildings) to define the boundaries of the site, but do not include biological features.
7. Now, when the boards are separated, each team will have a section of the master map on which to add the biological details.

Example of a data-board overview map



MAPPING A STUDY SITE

ACTION

1. Construction of the Key
a. On site, point out the boundaries of the study site.
b. Lay out the individual boards so the entire study site is illustrated. Tell the group they are going to map the features of this site by using colored tags to represent organisms. Before they can begin, however, they need to construct a key to tell them what each colored tag means.
c. Show them the eight different colors of tags, and ask the group to suggest a different-colored tag for eight major biological features of the site.
Example of key for a park mapping site:

Dark Green	trees
Light Green	bushes
Yellow	grasses or lawn
Black	dead trees or logs
Red	weed beds
Gray	ant hill
Brown	gopher holes
Orange	bird's nest

Special features such as 12 trees instead of just 1 or 2 can be noted with felt pens.

2. Divide the group into teams and give each team a data-board section of the map. Review the limits of each section and give each team a bag of colored tags.
3. Ask each team to duplicate the key on their own data-board section map.
4. Introduce the challenge to the teams: Using the colored tags and marking pen go to your section of the activity site and map the major features. A precise scale for the map is not necessary; simply place the colored labels on the map approximately where features are located in the study site.
5. When everyone is finished exploring and mapping their area, put the sections of the map together and admire the completed map. Encourage the naming of certain landmarks and write them on the map (e.g. "Boat Dock Cove," "Eagle Mountain," "Look-Out Rock," or "Frog Island").

WHAT DO YOU THINK?

1. What is the most common color on each map section and which features do these four colors represent?
2. What is the most common color on the overall map and which feature does it represent?
3. Which section contains the greatest number of different colors and which section the least? What might explain the differences in these two sections?
4. In which section do you suppose man's influence is most evident? In which section is it least evident?
5. In what ways do you think man may have affected the biological features of the activity site?
6. What do you think this site looked like fifty years ago?
7. What do you think this site will look like fifty years from now?

WHAT TO DO NEXT

What Lives Here?
Habitat Sun Prints
Plant Distribution Patterns
Sticklers

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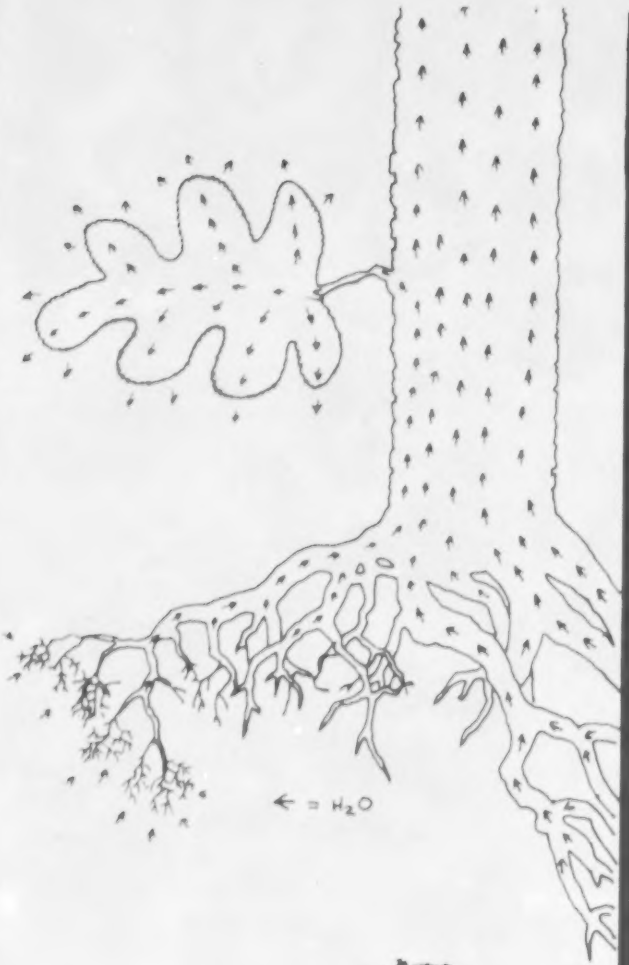

Transpiration is the evaporation of water from plant surfaces, primarily leaves, into the air. Most plants transpire approximately 75 percent of the water taken in by their roots. Most of the water is lost through small openings on the leaf and stem surfaces called **stomates**. The stomates can regulate transpiration by opening and closing.

Fluctuations in transpiration occur seasonally and even daily depending on environmental factors such as wind, light, moisture, and temperature. In the summer, for example, a maple tree transpires up to 200 liters per day, but in winter when its leaves are dropped, transpiration is minimal.

Plants in dry climates must retain a greater percentage of water than plants in wetter climates. Adaptations in the size, shape, and number of stomates are instrumental in reducing transpiration.

MEASURE THE MOISTURE RELEASED FROM DIFFERENT KINDS OF LEAVES BY OBSERVING THE COLOR CHANGE OF COBALT CHLORIDE PAPER.

MATERIALS

Cobalt chloride paper*
OR Cobalt chloride crystals*
table salt
water and bowl
filter paper or some other absorbent paper (paper towels)
scotch tape
plastic bags
clothes pins
twist-ties
plastic food wrap
paper clips
hand lenses (optional) for looking closely at leaves

*Cobalt chloride paper or crystals may be obtained from junior or senior high school science departments, chemical supply houses, or the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

PREPARATION

To prepare cobalt chloride paper:
Mix two teaspoons cobalt chloride crystals, one teaspoon salt, and four teaspoons water in a bowl until all crystals are dissolved. Soak paper pieces (2 cm. by 5 cm.) in the pink solution. Dry the paper by hanging it from clothespins or matting it between paper towels. The cobalt chloride paper will turn blue when it dries.
If you prefer, you may purchase commercially-prepared cobalt chloride paper.

How to use the paper:
To observe color change, place a piece of clear tape on both sides of one section of the paper. The taped area will remain blue and the uncovered area will turn pink when exposed to moisture.
Place dry cobalt chloride paper on living leaves that are attached to trees or bushes. Use paper clips to hold the paper in place. Enclose the paper and leaf in a plastic bag or plastic food wrap. Measure and compare the time it takes different leaves to turn the blue paper to pink. (Allow 5-15 minutes for the color change.)

Action Card
MOISTURE MAKERS

Outdoor Biology Instructional Strategies

Compare transpiration of a dead leaf with a live leaf attached to the same tree.

Action Card
MOISTURE MAKERS

Outdoor Biology Instructional Strategies

Compare transpiration of a thick juicy leaf (succulent) with a thin, flat leaf.

Action Card
MOISTURE MAKERS

Outdoor Biology Instructional Strategies

Compare transpiration of a hairy-surfaced leaf with a smooth-surfaced leaf.

Action Card
MOISTURE MAKERS

Outdoor Biology Instructional Strategies

Compare transpiration of a leaf in the shade with a leaf of the same size and shape in the sun.

Technique Card
MOISTURE MAKERS

How to use cobalt chloride paper:

To observe color change, place a piece of clear tape on both sides of one section of the paper. The taped area will remain blue and the uncovered area will turn pink when exposed to moisture.

Place dry cobalt chloride paper on living leaves that are attached to trees or bushes. Use paper clips to hold the paper in place. Enclose the paper and leaf in a plastic bag or plastic food wrap. Measure and compare the time it takes different leaves to turn the blue paper to pink.

Technique Card
MOISTURE MAKERS

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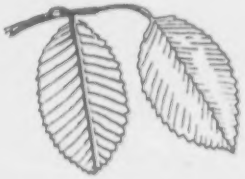
Action Card
MOISTURE MAKERS

Compare transpiration of a small leaf and a large leaf on the same plant.

Action Card
MOISTURE MAKERS

Compare transpiration of the upper side of one leaf with the lower side of another leaf. The two leaves should be the same kind and approximately the same size. (Place the cobalt chloride paper on top of one leaf and hold in place with a paper clip. Repeat the procedure on the bottom side of another leaf.)



Action Card
MOISTURE MAKERS

Compare transpiration of a stem with a leaf of the same plant.

Action Card
MOISTURE MAKERS

Compare transpiration of a pine needle with a broad leaf.

Technique Card
MOISTURE MAKERS

Outdoor Biology Instructional Strategies

How to use cobalt chloride paper:

To observe color change, place a piece of clear tape on both sides of one section of the paper. The taped area will remain blue and the uncovered area will turn pink when exposed to moisture.

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Technique Card
MOISTURE MAKERS

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Technique Card
MOISTURE MAKERS

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Technique Card
MOISTURE MAKERS

Outdoor Biology Instructional Strategies

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MOISTURE MAKERS

Transpiration of Leaves

ACTION

1. Explain the method for use of cobalt chloride paper as a moisture-measuring device. (Instructions appear on the reverse side of each **Action Card**.)
2. Distribute **Action Cards.**

☐ Compare transpiration of a small leaf and a large leaf on the same plant.

☐ Compare transpiration of a stem with a leaf of the same plant.

☐ Compare transpiration of a pine needle with a broad leaf.

☐ Compare transpiration of a dead leaf with a live leaf attached to the same tree.

☐ Compare transpiration of a thick, juicy leaf (succulent) with a thin, flat leaf.

☐ Compare transpiration of a hairy-surfaced leaf with a smooth-surfaced leaf.

☐ Compare transpiration of a leaf in the shade with a leaf of the same size and shape in the sun.

☐ Compare transpiration of the upper side of one leaf with the lower side of another leaf. The two leaves should be the same kind and approximately the same size. (Place the cobalt chloride paper on top of one leaf and hold in place with a paper clip. Repeat the procedure on the bottom side of another leaf.)

3. Have each participant complete the activity suggested on two or more of the **Action Cards**.

WHAT DO YOU THINK?

☐ Why did we put scotch tape on the filter paper?

☐ What type of leaf transpires the most?

Describe its characteristics (size, shape) and location (in sun, shade).

☐ What type of leaf transpires the least?

Describe its characteristics (size, shape) and location (in sun, shade).

☐ How might climate affect the rate of transpiration?

☐ What properties might you expect plant leaves to have in deserts, mountain tops, sea coasts, or lawns?

FOLLOW THROUGH

A. Effects of excessive watering on transpiration.

1. Choose two plants of the same type and approximately the same size.
2. Label plants A and B.
3. Water plant A the day before and just before measuring the rate of transpiration. Do not water plant B.
4. Measure the rate of transpiration and compare the results.

B. Compare the transpiration of one type of plant at different times of the day.

C. Transpiration of a potted plant:

1. Obtain several potted plants in metal, plastic, or styrofoam containers that have no drainage holes in the bottom.
2. Water the plants only once.
3. Cover the soil surface with foil, plastic food wrap, or paraffin to prevent evaporation of water from the soil. Weigh the entire set-up.
4. As a control, set up an identical pot. Add soil and water, but replace the plant with a wooden stick. Cover the soil surface as before, and weigh the entire set-up.
5. Continue to weigh the plants and control set-up every other day. The difference in weight loss between the control and experimental pots is the water lost through transpiration.

WHAT TO DO NEXT

Terrestrial Hi-Lo Hunt
Invent a Plant
Seed Dispersal

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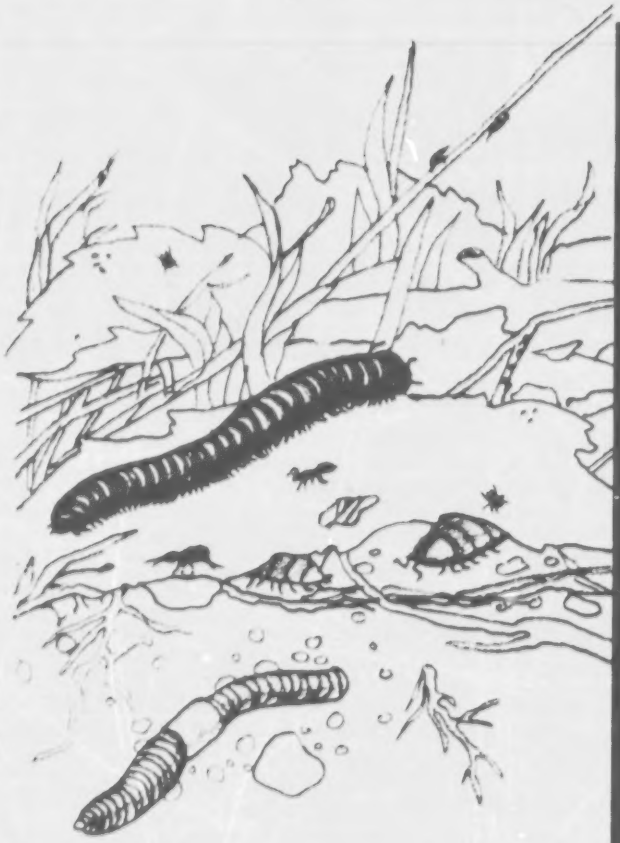

There is a natural recycling of earth s resources that prevents the depletion of essential raw materials. Scavengers such as earthworms and sowbugs begin the recycling process by eating dead matter and breaking it into smaller parts. Any dead matter or feces not eaten by scavengers serves as nutrient sources for decomposers such as fungi and bacteria. These decomposers complete the recycling process by utilizing the nutrients and returning only the raw materials, such as minerals, to the environment for use by other plants and animals.

Recycling glass and other man-made litter is not the same as the natural recycling process. Man-made litter can be recycled and made useful to man again, but it ordinarily is not broken down into nutrients that are essential to living plants and animals.

COMPARE THE NATURAL RECYCLING PROCESS OF DEAD VEGETATION IN DIFFERENT TYPES OF CONTAINERS BURIED IN THE SOIL.

MATERIALS

For the total group:

scales (recipe, postal, etc.)
1 ball of string
trowels or other digging tools

For each team:

about one-half kilogram of dead vegetation (collect in study area or get discarded leafy vegetables from a supermarket)
1 bag which larger scavengers can't get into (nylon net, panty hose, etc.)
1 bag with larger holes that scavengers can get through (hair nets)
1 plastic bag with no holes
1 stake or marker flag
1 pencil

DATA CHART
NATURAL RECYCLING IN SOIL

Outdoor Biology Instructional Strategies

container	weight			appearance of contents	
	before	after	differ-ence	before	after
Nylon Stocking					
Mesh Bag with large holes					
Plastic Bag					

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NATURAL RECYCLING IN SOIL

ACTION

1. Distribute data charts and one of each of the three types of bags to each team.
2. Each team can then weigh three equivalent samples of dead vegetation and place one sample in each bag. Record weights of the filled bags on the data chart.
3. Close the opening of each bag and tie it firmly.
4. Dig a hole large enough to hold the three bags. Place all bags in the hole at the same depth and separate from each other by 5 or more cm. of soil.
5. Cover the bags with 5 cm. of soil.
6. Mark the site with a stake.
7. If desired as a control, use identical procedures and bury three *empty* bags. (Be sure to record their weights).
8. Allow 2-8 weeks before recovering the bags.
9. Dig up the bags, weigh them, and inspect the contents.
10. Participants should compare and discuss results.

Data Chart

container	weight			appearance of contents	
	before	after	diff-erence	before	after
Nylon Stocking					
Mesh Bag with large holes					
Plastic Bag					

WHAT DO YOU THINK?

- Does the type of bag have an influence on the amount of change?
- Can you explain the changes in the three bags of vegetation?
- What would happen if dead leaves did not decompose?
- Was there a difference in the weight of the control bags before and after the experiment? If so, why? What effect does this have on your experiment?
- Could the "wetness" of the soil in which the bags were buried have any effect?
- What effect do you think the type of soil may have on the decomposition?

FOLLOW UP

Place equal amounts of the same type of dead vegetation into several mesh bags. Weigh each and record the weight. Place one bag about 8 or 10 cm. above the soil (hanging from a stake), place one on top of the soil, and bury one about 8 cm. below the soil surface. A fourth bag can be buried deeper. Mark each site with a stake.

After 2-8 weeks recover the bags. Weigh them, and visually compare the contents.

WHAT TO DO NEXT

Natural Recycling in Water
Water Holes to Mini-Ponds

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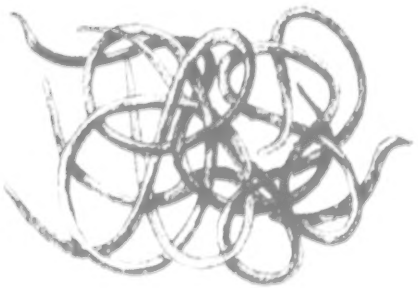

Living organisms, including man, are constantly using the earth's resources: food and raw materials from which food is made. Plants use raw materials such as water, minerals, and carbon dioxide to make food. Both plants and animals use this food to carry on all the life processes.

After these organisms or their products are eaten, the food is "used up" and only the raw materials remain. Once these raw materials are no longer in the form of food, they can be used again by plants as the components of new food. This process of reusing raw materials is called **recycling**.

In an aquatic community, scavengers, such as snails, crayfish, and tadpoles, begin the recycling process by eating dead matter. Decomposers, such as bacteria, molds, and tiny roundworms, complete natural recycling by reducing and breaking down organisms and animal waste so they can be reused by living plants and animals.

Recycling man-made litter is not the same as the natural recycling process. Man-made litter can be recycled and made useful to man again, but it ordinarily may not be broken down into nutrients that living plants and animals can use.

COMPARE THE RESULTS OF NATURAL RECYCLING OF DEAD VEGETATION IN DIFFERENT TYPES OF CONTAINERS PLACED IN AN AQUATIC ENVIRONMENT.

MATERIALS

For the group:

scales (recipe or postal)
1 ball of string

For each student:

Leafy vegetables, potatoes, carrots, or other such plant material you can find in a grocer's garbage can. Fresh grass will also work, but dried leaves take much too long to decay
1 nylon stocking
1 large-mesh, plastic or nylon bag
1 plastic bag without holes
1 wooden stake
1 pencil
1 data chart

PREPARATION

Duplicate enough **Data Charts** and the directions on the reverse side for each participant to have a set.

DATA CHART
NATURAL RECYCLING IN WATER

Outdoor Biology Instructional Strategies

container	weight			appearance of bag & contents	
	before	after	differ-ence	before	after
Nylon stocking with dead vegetation					
Mesh bag with dead vegetation					
Plastic bag with dead vegetation					

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A. Put some of each type of vegetable material available into each bag.
B. Observe each vegetable type and record its appearance on your data card.
C. Close and tie each bag firmly with the string, leaving extra string to tie the bag to a stake.
D. Dip all the bags in water, remove them and allow to drip for one minute. Weigh the bags and record the weights on the data card.
E. Tie all three bags to a stake. Use the stake to firmly position the bags under water at some convenient place in an aquatic habitat (pond, stream, salt water marsh, etc.).

NATURAL RECYCLING IN WATER

ACTION

1. Distribute a Data Chart and three different bags to each participant.
2. Discuss the instructions which appear on the reverse side of the chart.

A. Put some of each type of vegetable material available into each bag.

B. Observe each vegetable type and record its appearance on your data card.

C. Close and tie each bag firmly with the string, leaving extra string to tie the bag to a stake.

D. Dip all the bags in water, remove them and allow to drip for one minute. Weigh the bags and record the weights on the data card.

E. Tie all three bags to a stake. Use the stake to firmly position the bags under water at some convenient place in an aquatic habitat (pond, stream, salt water marsh, etc.).

3. Allow one to eight weeks before retrieving the bags. Drain the bags for one minute, weigh each bag, and record the weights on the data card.
4. Open the bags, observe the contents, and record the appearance of the contents on the data card.
5. Participants can bring their bags together for comparison of results.

WHAT DO YOU THINK?

- Can you explain the changes in the three bags of vegetation? What does the kind of bag have to do with it?
- What would happen if dead vegetation did not decompose?

DATA CHART

container	weight			appearance of bag & contents	
	before	after	difference	before	after
Nylon stocking with dead vegetation					
Mesh bag with dead vegetation					
Plastic bag with dead vegetation					

FOLLOW UP

Using the same technique, compare natural recycling in running water with natural recycling in still water.

WHAT TO DO NEXT

What Lives Here?
Water Holes to Mini-Ponds
Natural Recycling in Soil

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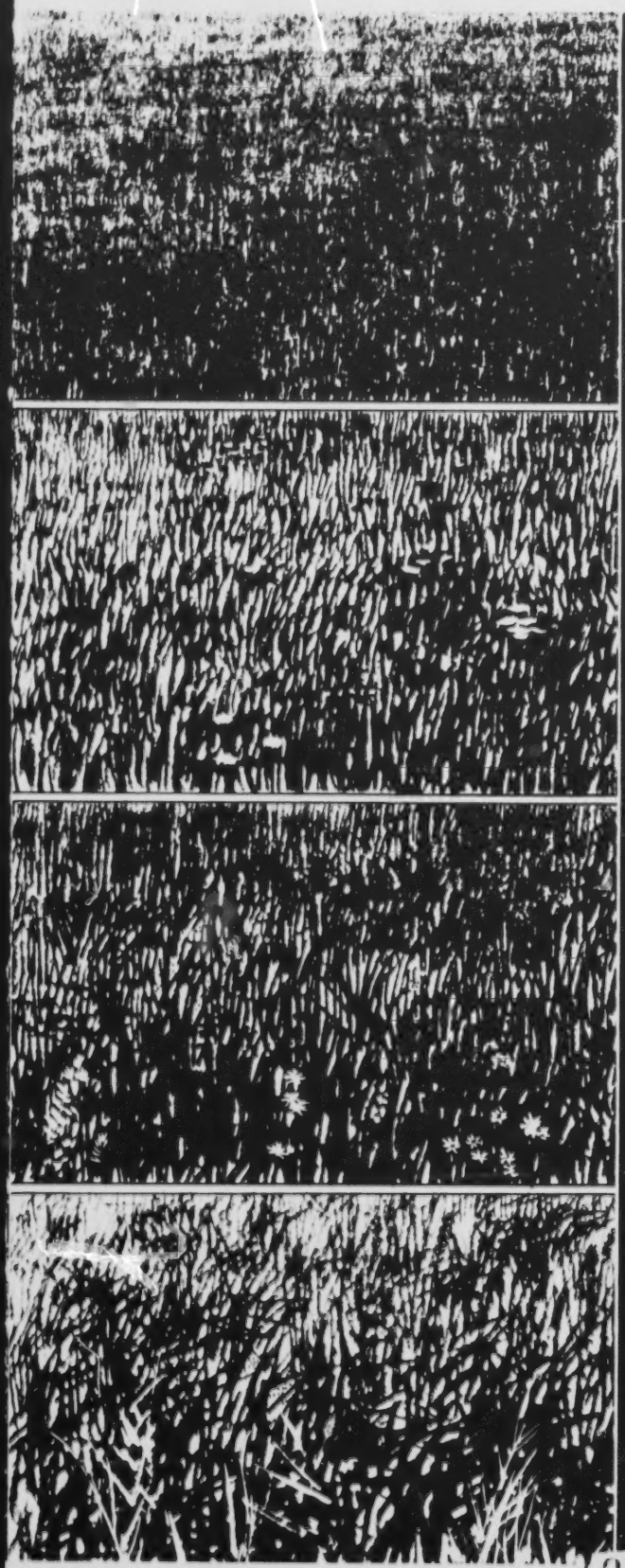

A lawn is a grassland community that is completely under the control of man. Once a lawn is established, continual work is necessary to maintain it: watering, fertilizing, mowing, weeding, aerating, dethatching, and pest controlling. If these maintenance procedures are abandoned, the nature of the community changes. Because lawn grasses are not generally native to the site where a lawn is desired, they are extremely susceptible to competition from native species. Man's role is to maintain a supporting environment for lawn grasses.

RELEASE A PORTION OF YOUR LAWN FROM MAN'S CONTROL. OBSERVE THE RESULTING CHANGES IN THE LAWN COMMUNITY.

In this activity, one major alteration is made in a lawn study site: the influence of man is removed. Do it by ending all (or as many as possible) of the maintenance practices in the lawn community: no more watering, mowing, and so on. Carefully observe changes in the community as it goes further and further out of control. Comparisons are easy as only a small area of the total lawn is left to go out of control. OBIS can't predict exactly *what* changes will occur in your out-of-control, but OBIS can predict that changes *will* occur.

WHAT TO EXPECT

First you will notice an increase in the size of weeds in the lawn and a tendency for lawn grasses to bloom (go to seed). This is largely due to discontinuation of mowing.

If you are able to prevent your "out-of-control" from being watered, you will notice the lawn grasses failing. Native plants (weeds), better able to compete under out-of-control conditions, will increase in size and number.

Micro-environments will change. Taller weeds will provide shade and cooler temperatures. Places where the exposed foliage of plant cover has died will be hot and dry.

Increased plant diversity will result in increased diversity in hopping and flying animals. Where exposed grass has died and dried out, small scavenging animals may migrate away to moister areas.

Ultimately, no indication of a lawn will remain. You will end up with a plot of native plants (a weed bed) and associated animals. Your lawn will be not only out of control, but out of sight!

MATERIALS

For the group:

1 fence (to identify the out-of-control area)

enough of the following materials for the group to conduct experiments, make measurements, and assist in observations:

meter sticks

magnifiers

wire for quadrats

collection cups

paper and pencils

1 data board and markers

OUT OF CONTROL

PREPARATION

It is essential to secure permission to allow part of your study lawn to go out of control. It is also important that the person responsible for the maintenance of the lawn is aware of your experiment. This may not be a problem if the lawn is private, but it is if you want to use part of a public park or school lawn.

ACTION

Once you have selected the area for your "out-of-control" and have secured the permission and cooperation necessary to proceed, gather your group at the lawn and briefly discuss the characteristics of a lawn. Two points should be discussed:

1. A lawn is an expanse of grass, spiced with a variety of animals and weedy plants.
2. A lawn is managed continually by man.

Ask what man must do to maintain a lawn. As ideas are mentioned, list them on your data board: water, fertilize, mow, plant, weed, control pests, aerate, and dethatch. Ask the students, "What would happen to a lawn if someone stopped these management practices?" After some discussion, ask, "How can we find out for sure?" Perhaps they will say, "Do it — let the lawn go without any management!" Invite the group to help design an experiment to answer the question. Introduce the term "out-of-control" for the name of the experimental study area, and "control" for the lawn area that will continue to be managed. Ten square meters is an adequate area for an "out-of-control" site. Choose a suitable area and mark its boundaries with a fence or stakes. When the boundaries are marked, gather the group together and discuss possible investigations that can be undertaken to monitor the changes that occur.

FOLLOW THROUGH

☐ Do any of the suggested "WHAT TO DO NEXT" activities, comparing "control" and "out-of-control" areas.

☐ Make some charts on your data board and keep records of specific changes such as height of plants, number of weeds that appear, or number of lawn grasses which disappear.

WHAT TO DO NEXT

Water Holes to Mini-Ponds
Bean Bugs
Animals in a Grassland
Seed Dispersal
Terrestrial Hi-Lo Hunt

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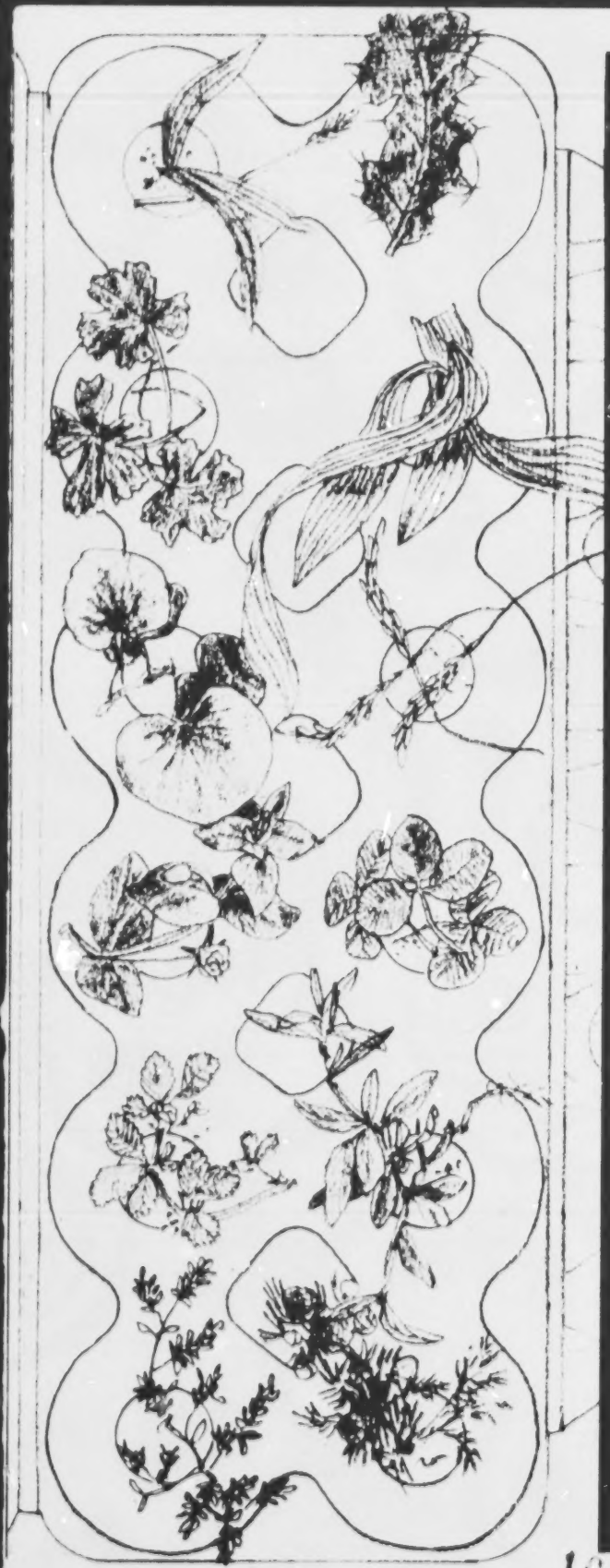

This activity is designed to develop interest and skill in sampling populations. A **population** is a group of organisms of the same kind that live and reproduce in a given area.

Participants in the hunt investigate the diversity of plants in a selected area. Using egg cartons, the group collects parts of plants. By combining the evidence from the teams' collections into one large collection, the group observes differences in the various plants found in the study area. The results are used in developing the concept of species. For our purposes, **species** is used to denote each different kind of plant found.

FIND AS MANY DIFFERENT PLANTS AS YOU CAN IN A STUDY SITE.

MATERIALS

For the group:
25 paper or plastic cups*

For each team:
(3 to 5 participants)
Lawn Guide
2 egg cartons
Hand lens
*Margarine or cottage cheese containers are fine.

Note: Certain hard-to-get items, such as hand lenses (magnifying lenses) may be purchased from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

PREPARATION

Select a site for the hunt; avoid sites with rare, delicate, or unusual plants. A lawn, vacant lot, open field, or other area where there is a variety of plants is suitable. Clearly mark the boundaries of the site before the hunt begins. The entire activity can be carried out in forty-five minutes. Allow fifteen to thirty minutes for the investigation of the site, the collection comparison, and sorting of samples. Based on observed interest, increase or shorten this time.

PLANT HUNT

ACTION

1. Organize the group into teams of three to five participants.
Give each team two egg cartons and a hand lens.

2. Define the boundaries of the study site.

3. Challenge each team to find and collect as many different kinds of plants as they can on the site. You may make it a contest among teams.
a. Two leaves, or pieces, of each different kind of plant are collected.
b. One piece is placed in a compartment of the team's egg carton. The other piece is placed in one of the paper or plastic cups. Set the cups out in the middle of the site. If two teams collect parts of the same plant they should place the parts in the same cup. Each cup should contain only one kind of plant. In this way, all the different plants collected by all teams are combined and sorted in the cups.

4. Observe and discuss each team's findings.
a. Discuss whether each piece of plant in a team's collection is from a different kind of plant.
b. Using hand lenses and comparison of whole plants, resolve disagreements where possible.
c. Observe and discuss whether each cup in the center contains a different kind of plant. Use hand lenses to help decide.

5. Introduce the term **species.** Individuals and teams will disagree regarding whether or not certain plants in a team's collection are the same or different kinds. This is a good time to introduce the concept of species and to emphasize that some disagreements cannot be resolved. Each different kind of plant found is identified as a separate species.

6. Distribute OBIS *Lawn Guides* and have the group compare plants collected with those pictured in the guide. Many participants will enjoy finding names for the plants they have found.

FOLLOW THROUGH

1. Interested participants can further identify their collected plants by using standard biological keys and plant guides.
2. Compare the diversity of plants found at different times of the year or after a rainy or dry period.
3. Search for additional plants on the site. What was missed?
4. Conduct a plant hunt in two different environments such as a lawn and a meadow; compare results.

WHAT TO DO NEXT

Bean Bugs
Animals in a Grassland
Plant Distribution Patterns
Plants Around a Building

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The physical environment is the complex interaction of a number of changeable factors: wind, moisture, temperature, light, slope, etc. These changeable factors, which we call **environmental variables**, affect all living things. Man constructs buildings to alter *his* environment, and in doing so, affects the environment of other organisms. Many variables are influenced. Buildings create shade where direct sun shined before. Buildings change wind patterns. Moisture collects in places previously dry, and traffic from human feet compacts the soil. Man selectively plants and maintains part or all of the area around a building. In this activity, a walk around the building enables one to appreciate the effect that the structure and its maintenance have on life around it. The building affects distribution of light, moisture, temperature, and traffic. Man may garden the area around the building more or less intensively. This gardening is found to have significant effects on the number, kind, and size of plants growing in the vicinity.

DISCOVER HOW THE CONDITIONS AROUND A BUILDING AFFECT THE GROWTH OF PLANTS.

MATERIALS

For each team of three or four participants:
outline map of building and environs
marker
pencil or crayon
set of **Action Cards**

PREPARATION

1. Select a building site for the activity. Any kind of building is fine, but one in an open area is preferred. Results will be quite different depending on whether or not the perimeter of the building is gardened.
2. Prepare, and have available, one outline map of the building and the land around it for each team of three or four participants. Also prepare one large outline map. The map needs to show only the outline of the building and any other significant nearby structures.
3. Reproduce enough **Action Cards** for each team to have one card. Include some of your own that reflect features of the particular building you have chosen.

Action Card

PLANTS AROUND A BUILDING

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Find and mark on your map those places where plants seem to grow much larger than the same kind of plants in other places around the building. What do you think is causing this, in each case?

Action Card

PLANTS AROUND A BUILDING

Outdoor Biology Instructional Strategies

Find and mark on your map those places where plants seem to grow much smaller than the same kind of plants in other places around the building. What do you think is causing this, in each case?

Action Card

PLANTS AROUND A BUILDING

Outdoor Biology Instructional Strategies

Find and mark on your map those places where the number of plants in a small area is high. What do you think is causing this, in each case?

Action Card

PLANTS AROUND A BUILDING

Outdoor Biology Instructional Strategies

Find and mark on your map those places where the number of plants in a small area is very low. What do you think is causing this, in each case?

Action Card

PLANTS AROUND A BUILDING

Outdoor Biology Instructional Strategies

Find and mark on your map those places where no plants grow. What do you think is causing this, in each case?

Action Card

PLANTS AROUND A BUILDING

Outdoor Biology Instructional Strategies

Find and mark on your map the least common plant growing around the building. Are there any special conditions which permit it to grow in that place or places?

Action Card

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PLANTS AROUND A BUILDING

ACTION

1. Divide the group into teams of two to four.
2. Distribute outline maps and help the group figure out orientation of the map to the building.
3. Distribute **Action Cards** and tell the teams to find as many examples as they can of the situation described on the team card. They should mark each place selected on the outline map.

Action Cards

☐ Find and mark on your map those places where plants seem to grow much larger than the same kind of plants in other places around the building. What do you think is causing this, in each case?

☐ Find and mark on your map those places where plants seem to grow much smaller than the same kind of plants in other places around the building. What do you think is causing this, in each case?

☐ Find and mark on your map those places where the number of plants in a small area is high. What do you think is causing this, in each case?

☐ Find and mark on your map those places where the number of plants in a small area is very low. What do you think is causing this, in each case?

☐ Find and mark on your map those places where no plants grow. What do you think is causing this, in each case?

☐ Find and mark on your map the least common plant growing around the building. Are there any special conditions which permit it to grow in that place or places?

4. After fifteen or twenty minutes, gather the group together, have them transfer their records to a large outline map, and discuss what might have caused the observed results. Introduce the idea that environmental factors, such as moisture, light, temperature, or trampling might be responsible.

FOLLOW UP

1. Reinforce the concept of environmental variable. Select a variable (temperature, moisture, light, etc.) and tour the site observing how plants respond to that variable. Challenge the participants to relate the results to the evidence you have acquired on plant growth around the building. (A more quantitative measurement of environmental variables is obtained in the *Terrestrial Hi-Lo Hunt* activity.)
2. Orient a building map according to the compass, and have participants hunt for evidence of differences in plant growth on the north, south, east, and west sides of the building. Can the youngsters relate these differences to environmental factors caused by the building's exposure? What about the effect of gardening or the lack of it?
3. Carry out the activity at a different season of the year, and compare the results in relation to each environmental factor.

WHAT TO DO NEXT

Terrestrial Hi-Lo Hunt
Plant Hunt
Invent a Plant

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Seed dispersal is dependent on many agents:

Most plants produce seeds which may grow into new plants. In order to survive, these plants require such raw materials as minerals, air, and water. Energy, in the form of sunlight, is required to transform these raw materials into nutrients.

A seed dropped directly underneath a plant may have difficulty growing because the older plant, in the process of insuring its own survival, deprives the new plant of sunlight or one or more of the necessary raw materials.

One of the adaptations of plants which enables species to continue is a mechanism which distributes seeds to other growing sites, some of which may be more favorable. This seed dispersal mechanism is one type of plant adaptation. An **adaptation** is any special feature of an organism that improves its chances of surviving and reproducing.

MODIFY DRIED BEANS OR PEAS SO THAT THEY MAY BE DISPERSED BY VARIOUS NATURAL FORCES.

MATERIALS

For the Group:

bag of dried beans or peas
(seeds of any kind will do)
balsa wood and/or
construction paper
tape
paste or glue
rubber bands
toothpicks
red tempera •
balloons •
scissors
pencil
plastic bag •
pieces of cork •
cotton and/or feathers •
small metal springs •
duplicated **Action Cards**
any other useful materials

• optional materials

SEED-GO

SEED DISPERSAL

Look carefully at the plants in your surroundings. Decide how each plant disperses seeds and glue or tape a sample of its seed in the proper box. Some seeds may be dispersed in more than one way. The first person with five seeds in a row, in any direction, wins (same as Bingo).

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	grass	trees	bushes	weeds	garden plants
wind					
water					
mechanical					
animals					
man					

REMEMBER:
In order to win, you may have to convince others that you are correct.

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Action Card
SEED DISPERSAL

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Modify your seed to fly at least three feet.

Action Card

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Action Card

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Action Card

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Action Card
SEED DISPERSAL

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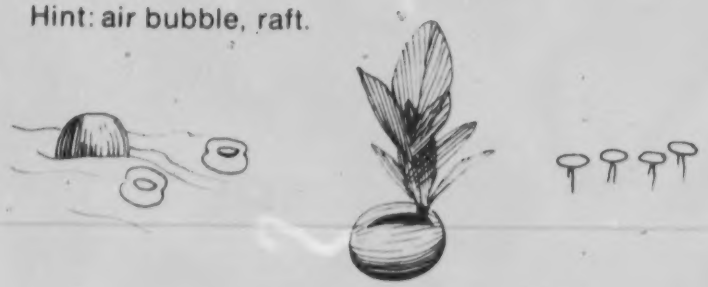
Modify your seed to float on water at least five minutes.

Hint: air bubble, raft.



Action Card
SEED DISPERSAL

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Modify your seed with a mechanism that will throw the seed two feet away from the parent plant.

Hint: burst, split.

Action Card
SEED DISPERSAL

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Modify your seed to attract a bird or other animal.

Hint: bright, tasty fruits with seeds inside.

Action Card
SEED DISPERSAL

Outdoor Biology Instructional Strategies

Modify your seed to hitchhike on an animal or man for twenty feet.

SEED DISPERSAL-ADAPTATION

ACTION

1. Tell the group that not all seeds can grow where they fall and that some seeds are dispersed (carried, blown, or pushed away).
2. Distribute the **Action Cards**, introduce the challenge, and give everyone a bean seed to be dispersed.
3. **Action Cards**
   - Modify your seed to float on water at least five minutes.
     Hint: air bubble, raft.
   - Modify your seed with a mechanism that will throw the seed two feet away from the parent plant.
     Hint: burst, split.
   - Modify your seed to attract a bird or other animal.
     Hint: Bright, tasty fruits with seeds inside.
   - Modify your seed to hitchhike on an animal or man for twenty feet.
   - Modify your seed to fly at least three feet.
   - Blank cards may be used to add other modifications you or the youngsters think seeds have.
4. Provide the group with materials for modifying their seeds for dispersal. Allow time for construction of the adaptations.
5. When everyone is finished, call upon each person (or team) to read his card and demonstrate his dispersal invention. You may have to provide a bucket of water for testing floating seeds if a pond or stream is not available.
6. Have the youngsters search the study site for seeds which seem to be adapted for dispersal.

WHAT DO YOU THINK?

1. Can you find plants that actually have features like the seed dispersal mechanism you constructed?
2. What might happen if seed dispersal mechanisms did not exist?

FOLLOW UP

Distribute duplicated **SEED-GO** cards and some glue or tape. **SEED-GO** is played like Bingo. When someone says he has won, encourage questions from the others so the winner can explain his reasoning.

WHAT TO DO NEXT

Adaptation–Predator-Prey
Invent an Animal
Invent a Plant

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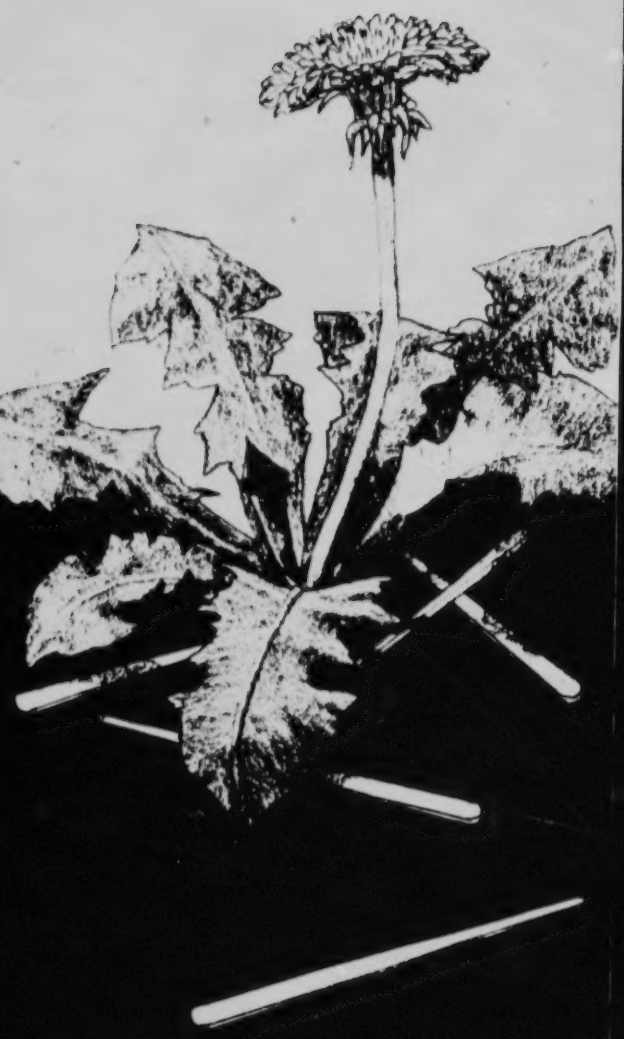
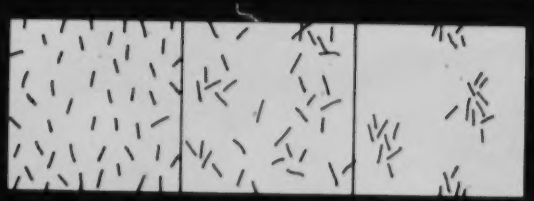


Every plant and animal lives someplace, but, of course, not all live in the same place. The particular place where any organism lives is called its **habitat**. Within its habitat, an organism is invariably associated with others of its kind.

In this activity, a habitat is selected for a simulated lawn animal, the "stickler." Sticklers can be toothpicks, bean seeds, or other materials which will not contaminate a habitat if any are left behind. Select a lawn habitat and a distribution for your sticklers, place them on the lawn, and proceed to study them as if they were actual animals.

The way organisms spread out in their habitat is called their **distribution.** There are three basic kinds of distribution: uniform, random, and clumped. Uniform means evenly spread out in the habitat; random means scattered here and there in the habitat; and clumped means a number of organisms bunched together in one or several places in the habitat.



Uniform Random Clumped

The stickler simulation game is a good introduction to follow-through activities focusing on studies of living organisms. The game also helps develop the concepts of **habitat** and **distribution**.

DETERMINE THE HABITAT AND DISTRIBUTION OF LAWN STICKLERS.

MATERIALS

For the group:

1 box of flat toothpicks or some bean seeds
1 large data board (see the *OBIS Toolbox* folio)

For each participant:

1 data board (cardboard square 20 cm. by 20 cm., covered with blank paper)
1 pencil

PREPARATION

For maximum success, sticklers should be distributed on the lawn before participants arrive on the scene. Look over the site. What habitats are there? Are there dead leaves on the lawn? Are there some obvious edges around the lawn? Is there an abundance of a specific weed, like dandelions or clover? Any of these, and many other distinctive areas of the lawn environment, can be the stickler's habitat. Choose one (under dandelion leaves is often a good choice) and decide how to distribute the sticklers.

There are three types of distribution: uniform, random, or clumped. For uniform distribution, put single sticklers under the leaves of all the dandelions throughout the whole lawn. For random distribution, place single sticklers under dandelions selected randomly from the total population of lawn dandelions. Clumped distribution can be demonstrated by placing bunches of sticklers under dandelion leaves at randomly selected places throughout the lawn environment. Distribute at least 100 sticklers.

One way to provide experience with all three modes of distribution is to select three different small areas and plant each with a different distribution pattern. Another way is to stain three different sets of toothpicks with food coloring and distribute each color according to one of the three distribution patterns.

STICKLERS

ACTION

1. Hold up a stickler. Say, "This is an imaginary animal that lives on this lawn. It is called a stickler."
2. Distribute a data board to each participant and show him how to draw a quick map of the study area. Tell the youngsters to mark an X where each stickler is found. Emphasize that they should record, as accurately as possible, exactly where each stickler is found, and that sticklers should be removed from the study area as they are located.
3. Begin the search. Hold up your stickler again and say: "This is the stickler you are looking for. Let's try to find out where it lives." Circulate to see that the participants are following directions. Allow about twenty minutes for this part of the activity.

WHAT DO YOU THINK?

Has everyone given up? Call the group together and pool the data. Sketch a big map on the data board and start combining everyone's results. When all of the data is recorded, encourage discussion of the results, emphasizing these questions:

Where do sticklers live?

How do sticklers spread out in this area?

Introducing the terms habitat and distribution:

Near the end of the discussion, indicate that biologists use the term **habitat** to describe the place where an animal or plant lives. An organism's **habitat** is where an organism normally lives and where you would ordinarily go to find it. The term **distribution** is used to describe the way organisms spread out in their habitat. Describe the three types of distribution and ask participants to decide which type applies to the population of sticklers they have investigated.

FOLLOW THROUGH

Return to the study site and investigate the habitat and distribution of a real organism. This can be a free-wheeling investigation where each participant studies a plant or animal of his own choice. Or, if you can identify an organism that would provide a good habitat and distribution investigation, proceed exactly as in the stickler hunt. For instance, if there are ladybugs living on your lawn, catch one and say, "Here is another organism living in our study site. Let us see what we can find out about where it lives and how it is distributed." Proceed as before, but DON'T COLLECT organisms this time, because their removal might upset delicate ecological balances. Perhaps a plant would be an appropriate choice of organism for your study site.

☐ Walk to a new study site and investigate the habitat and distribution displayed by some other organisms.

☐ Play a game where some students search out an organism, determine its habitat and distribution, and describe that habitat and distribution to the group. Have the other students determine what the organisms are from the descriptions of habitats and distributions.

WHAT TO DO NEXT

Terrestrial Hi-Lo Hunt
Habitat Sun Prints
Habitats of the Pond

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The suitability of a habitat to support the life of any particular organism is determined by factors such as temperature, moisture, wind, and light. These factors, which do not remain constant but change in daily and seasonal patterns in any one location, are called **environmental variables.**

At any one time, a single environmental variable is usually not uniform in an area. The top of a hill might be windy, while at the same time, at the foot of the hill, the air may be calm.

An open, grassy area might be warm and dry from the sun, while just a few meters away, in the shade of a tree, it may be cool and moist.

Different values of environmental variables create different living conditions for plants and animals. Various organisms living in the same general area may exist under drastically different conditions due to variations in their micro (little) climate.

Searching out the locations of highest and lowest values for several environmental variables can prepare youngsters to investigate relationships between living organisms and their environment.

INVESTIGATE THE EXTREMES OF ENVIRONMENTAL VARIABLES IN A STUDY SITE: FIND THE LOCATIONS THAT ARE WARMEST, COOLEST, BRIGHTEST, DARKEST, WINDIEST, CALMEST, FLATTEST, AND STEEPEST.

PREPARATION

Read through the equipment cards listed under the **MATERIALS FOR THE HUNT** section and the activity text to determine the materials you will need for the environmental variables the children will be investigating. You may decide to investigate temperature, wind, and slope, but not the others. Thus you could ignore the photographic materials.

Construction of the instruments for the Hi-Lo Hunt can be an activity in itself. If you have time and wish to do so, duplicate all the equipment cards and have the youngsters prepare the instruments they will be using. This construction will take approximately one hour.

Make an overview map on your data board.

MATERIALS FOR THE HUNT:

For the group:
1 data board
1 felt pen

For each team of two:
1 pencil
2 Hi-Lo markers (1 stake with 3" x 5" card marked Hi and 1 stick with card marked Lo)

Depending on your decision on how you will conduct the activity (see **PREPARATION** section), one or more equipment cards and listed materials will be necessary. Listed below are the equipment cards necessary for the topics you decide to investigate. Equipment cards are located in the *OBIS Toolbox* folio.

Equipment Cards
"Measuring Slope"
"Measuring Wind Direction and Speed"
"Measuring Light"
Measuring temperature: no equipment card. Provide thermometers.

Note: Certain hard-to-get items listed on the equipment cards are available from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

Action Card
TERRESTRIAL HI-LO

Temperature. Use a thermometer to find the warmest and coolest spots in this site.

Temp. °C	Location
1.	
2.	
3.	
4.	
5.	
6.	

After you have finished taking temperature measurements, mark the warmest and coolest spots with your Hi-Lo markers.

Action Card
TERRESTRIAL HI-LO

Wind. Use your wind station to find the windiest and calmest spots in this site.

Wind Speed (rev/min)	Location
1.	
2.	
3.	
4.	
5.	
6.	

After you have finished taking wind measurements, mark the windiest and calmest spots with your Hi-Lo markers.

Action Card
TERRESTRIAL HI-LO

Slope. Use a slope-measuring device to find the steepest and flattest spots in this site.

Slope (cm/meter)	Location
1.	
2.	
3.	
4.	
5.	
6.	

After you have finished taking slope measurements, mark the steepest and flattest spots with your Hi-Lo markers.

Action Card
TERRESTRIAL HI-LO

Light. Use a light-measuring station to find the brightest and darkest spots in this site. (Remember: the darker the proof paper the brighter the spot.) Write the location of each exposure above each piece of proof paper.

After you have finished taking light measurements, mark the brightest and darkest spots with your Hi-Lo markers.

TERRESTRIAL HI-LO HUNT

THE HUNT

1. Point out the boundaries of the study site to the group.
2. Introduce The Hunt. Tell the youngsters they are going Hi-Lo Hunting. "Can you find the warmest and coolest, the brightest and darkest, the steepest and flattest, and the windiest and calmest spots in this site?"
3. Divide the group into teams of two to four and either designate or let each team choose the factor (light, wind, temperature, or slope) it will investigate. (If the group participated in the construction of the equipment, this decision has probably been made already.)
4. Distribute two markers to each team for marking the spots where the highest and lowest measurements are taken. Each team should print the variable it is testing on the two cards.
5. Hand each team the appropriate measuring device, **Action Card**, and a pencil. If the teams aren't already familiar with the Hi-Lo measuring devices, demonstrate each piece of equipment before handing it out.
6. Let the Hunt begin! Encourage the teams to take six or more measurements each in their hunt for Hi-Lo values.

AFTER THE HUNT

When all the teams have finished taking measurements and have set out their Hi-Lo markers, call the teams together and visit each of the Hi-Lo markers in the site. As the group moves from one marker to another, raise the following questions.

1. What features of this spot might explain why this is the *darkest* (insert appropriate term) place in this site?
2. Do any of the Hi-Lo measurements seem to relate to each other? For example, do the coolest spots also seem to be the darkest spots? Are the warmest spots also the brightest spots?
3. Will the warmest and coolest spots in the study area always be the warmest and coolest? How about the other measurements?
4. How might the direction of the wind cause some spots to be windy and others calm?
5. How might the time of day change the Hi-Lo measurements? The time of year?
6. Tell the group that physical factors, such as temperature, wind, light, and slope, that may change from minute to minute, day to day, or month to month, are called **environmental variables**.
7. In what ways do environmental variables affect man and other organisms?
8. In what ways does man affect environmental variables?

FOLLOW THROUGH

1. For an interesting comparison, conduct the activity again at a different time of day, on another day, or during a different season.
2. Measure the changes which occur from early morning through late evening.
3. Select a site with different characteristics (ask the group to describe the differences) and compare the environmental variables of the two sites. If you have just studied a lawn, you might want to try a dense woody area, bare soil, pavement, or a meadow.

WHAT TO DO NEXT

Aquatic Hi-Lo Hunt
ESP–Environmental Sensory Perception
Plants Around a Building

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A water hole is a good place to study colonization. This activity will enable students to observe and compare the transformation of fertilized and unfertilized water holes into mini-ponds. Wait to introduce the term colonization, and its meaning, until the group has observed the establishment of a population of organisms in a water hole – from two to four weeks. The appearance of life in a water hole transforms the basin of water into a mini-pond.

Colonization is the establishment of a population of organisms in an area where that organism did not occur previously. The process of colonization involves:

Arrival	windblown organisms organisms carried in by animals eggs laid
Survival	food light temperature
Population increase	reproduction arrival of more organisms
Population decrease	organisms eat other organisms organisms leave organisms die

OBSERVE AND COMPARE THE CHANGES IN A FERTILIZED AND UNFERTILIZED WATER HOLE.

WHAT TO EXPECT

You can expect your water holes to attract a variety of plants and animals. The major factors which will affect the variety and number of organisms are: the time of year (warm seasons are best), the amount of time the water has been standing (the longer the better), and nearness of the water holes to an established body of fresh water (close proximity to established populations speeds colonization).

The following events occurred in water holes set up on the West Coast during the spring and summer months. This situation involved two water holes: a wading pool lined with burlap and filled with water (the control), and a fertilized water hole that resembled the control in all respects except for the addition of ¼ liter of lawn fertilizer.

Various insects (especially springtails) and terrestrial debris started littering the surface of the water holes immediately after their completion. Ants and spiders moved in around the edges, while predaceous flies were attracted to the terrestrial insects on the water's surface.

Within a week, midges and mosquitoes deposited eggs in both water holes. The fertilized water hole turned green from algae growth between one and two weeks after it was set up. Damselflies and water beetles were temporary visitors that were observed after the midge and mosquito larvae appeared. Scavenger beetles colonized the water hole three weeks after its completion.

The life in the fertilized water hole was richer, more numerous, and grew much faster than life in the unfertilized water hole. More life probably appeared in the fertilized water hole because the fertilizer added nutrients that enabled algae, the basic food, to grow faster.

MATERIALS

For the group:

Shovels
hoes
2 children's wading pools or dish pans (any of the available sizes will do)
enough burlap to cover the inside of the pools or pans
hoses or buckets
fine-mesh hand net
2 large handfuls of fertilizer

For each team:

water hole charts (fertilized, unfertilized)
colored markers
Pond Guide

SUBSEQUENT MEETINGS:

For each team:

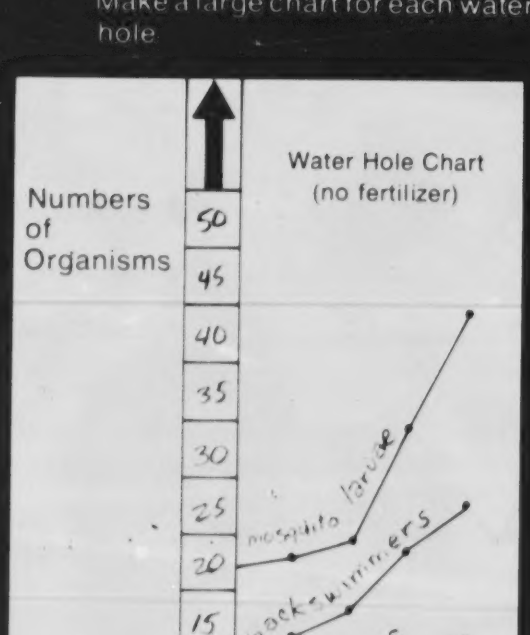
water hole charts
observation aids (bug boxes, clear plastic cups, spoons, and aquarium nets)
Pond Guides
*thermometers
*light meters
*meter sticks

*Refer to the "Basic Aquatic Equipment" and "Measuring Light" cards in the *OBIS Toolbox* folio.

WATER HOLES TO MINI-PONDS

PREPARATION

1. Selecting the site
   a. Look for a site preferably in the open and definitely not under any plant exuding sap or dropping lots of leaves.
   b. Consider the problem of filling and replenishing the holes.
   c. Obtain permission for digging holes.
2. Water hole charts
   Make a large chart for each water hole.



Date APRIL	2	9	16	23	30
Temperature	20°C				
Light	MED.				
Water level	+2cm				

Data for different organisms should be recorded in different colors.

ACTION

1. Introduce the challenge.
2. Divide the group into two teams.
3. Set up the water holes:
   a. Give each team a wading pool or dish pan.
   b. Have each team clear an area and dig a hole for a pool or pan, deep enough so that the rim is flush with the ground.
   c. Line the pools with burlap and tuck edges under rim of pools.
   d. Fill pools with water being careful not to add any organisms (filtering the water through fine-mesh nets may be necessary to prevent the addition of organisms if non-tap water is used).
   e. Have one team add fertilizer to its pool; the other team leaves its pool unfertilized.

For Subsequent Meetings:

1. Each team maintains the water level and monitors the development of its water hole.
2. Introduce the water hole charts and explain how the appearance and number of organisms should be recorded (see example).
3. During each meeting, the teams measure the physical conditions (light, temperature, and water level) of their water holes and record them on the water hole charts. Introduce and demonstrate use of thermometers and light meters for measuring temperature and light. Water levels can be measured with meter sticks.
4. The teams also monitor and record the biological changes, i.e., appearance or disappearance of life, or evidence of life, that occur in and around their water holes.

Suggest the hands - and - knees approach for close observation. *Pond Guides* may be helpful for identifying new organisms.

5. End each meeting by asking the teams to compare the development of the two water holes. Use the information on the water hole charts to make this comparison.
6. After the group has observed the presence of a population of organisms in a water hole, introduce the term **colonization** and its definition. Reinforce understanding of the term by using it in the context of the water holes, i.e., were there any new colonizers this week?

WHAT DO YOU THINK?

(Questions for discussion when you visit the water holes)

What changes can you see in each water hole?

Could there be any relationship between the biological changes and changes in physical conditions? (For example, could the appearance of organisms have anything to do with a change in light penetration in a water hole?)

What new animals have arrived?

What new plants have arrived?

What organisms have remained in the water hole over a period of time? Why?

What organisms have increased in numbers? How?

What organisms have decreased in numbers after a period of time? How?

What are the major differences between the two water holes? What are some explanations for these differences?

FOLLOW THROUGH

Construct other water holes controlling different variables such as: amount of light, water, or adding detergents, nutrients, sugar, salt, etc. Observe and compare the changes in these water holes.

If you have a dissolved oxygen test kit available, you may want to monitor the changes in the dissolved-oxygen content of the water holes.

WHAT TO DO NEXT

Natural Recycling in Water
Out of Control

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What lives in the water?

Plants?

Animals?

For man, water is an alien environment. Only by taking his own atmosphere with him can man spend any time beneath the water. Perhaps the alien nature of water accounts for the special fascination most people have for aquatic life. Whatever the reason, people seem to enjoy exploring an aquatic site and discovering what lives there.

This activity can be used as an exploratory introduction to the life in any aquatic system: pond, lake, reservoir, stream, or other body of water. After an investigation of life found in water, the term organism is introduced to the group. An **organism** is any living thing, plant or animal.

DISCOVER AND INVESTIGATE SOME OF THE PLANTS AND ANIMALS THAT LIVE IN YOUR AQUATIC STUDY SITE.

PREPARATION

Select a site that provides easy water access and an unobstructed view for easy supervision. Avoid sites with steep or slippery banks. Read the safety section in the *Leader's Survival Kit* folio.

MATERIALS

For the group:

data board (optional)

For each team of two:

Observation Aids*
Pond Guide
2 dip nets
2 Bug Boxes or magnifying lenses
1 white-bottomed container
2 team-site boundary markers
1 clear plastic cup
1 spoon

*See the "Basic Aquatic Equipment" card in the *OBIS Toolbox* folio for the use of these aids.

Note: Certain hard-to-get items such as Bug Boxes, magnifiers, and thermometers are available from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

BRING 'EM BACK ALIVE!

The success of this activity, and others that deal with living organisms, springs from the natural curiosity and interest people have for organisms living around them. Before your group begins this activity, ask for suggestions as to how life can be effectively investigated without causing it any harm. Use their suggestions to emphasize that care should be taken whenever a plant or animal is being studied. Organisms should be retained temporarily for observation purposes, and then returned unharmed to their source, so that others may find the same pleasure in the activity site.

WHAT LIVES HERE?

Life in the Water

ACTION

1. At the aquatic study site, challenge the group to find out what lives in the water.
2. Establish a conservation-oriented investigative procedure (see Bring 'em Back Alive!).
3. Divide your group into buddy teams of two. Tell the teams that buddies *must* stay together so that one can report any problem his buddy might encounter while working around the water.
4. Define the overall study-site limits and distribute the team markers. Let the teams mark off their boundaries and then return to the assembly point for their observation aids.
5. Show the teams the materials available for use.
   a. Demonstrate the use of the dip nets and Bug Boxes or magnifying lenses.
   b. Explain to the youngsters that the *Pond Guide* is available if they want to find out the name of any plant or animal they discover in the site.
6. Encourage the teams to return to their study sites and use the observation aids to observe and identify as many different kinds of plants and animals as they can. Save ten minutes at the end of the activity for sharing discoveries. One way to do this is to place all of the white-bottomed containers in a circle so all participants can see what was found.

WHAT DO YOU THINK?

- How many different plants and animals were found?
- Which plant and which animal was most abundant?
- Which plant and which animal was least abundant?
- Who found a plant or animal that nobody else found?
- Is this lake (stream, pond, etc.) richly or poorly populated with life?

FOLLOW THROUGH

End the discussion by explaining that plants and animals are called organisms by scientists. Write **organism** and its definition so that everyone can see it. Ask the group how many different kinds of organisms they can name.

WHAT TO DO NEXT

Habitats of the Pond
Animals in a Grassland
Sticklers
Habitat Sun Prints

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Who goes there? Except for chipmunks and sóme squirrels, most small mammals are creatures of the night. We do not see them, but there is evidence of their presence: footprints, missing cookies, and noises in the night. You can expose these creatures on an OBIS Mammal Hunt.

Animal droppings are another type of evidence left by animals living in an area. Animals frequently defecate and urinate on their trails to mark their home range. Different kinds of animals can be identified by the shape and size of their droppings.

In this activity, it is not necessary to handle animal droppings, but simply to locate and record them.

WITHOUT TRAPPING OR HARMING THEM, FIND EVIDENCE OF MAMMALS THAT YOU CANNOT SEE DURING THE DAY.

MATERIALS

1. OBIS Blacklight
   (Burgess fluorescent lamp with GE blacklight fluorescent bulb, F8T5-BLB). This longwave blacklight is safe, but children should be warned not to look directly into the light. Use regular flashlights when moving to and from the study area because some children will have less depth perception when using the blacklight for this purpose.
2. The blacklight fluorescent tracing powder
   This powder, while not toxic like insecticides, can be harmful if eaten or inhaled over a long period of time. Mix the powder into the baits with a stick and handle the powder carefully to minimize contact with the powder. The material passes through the animals' digestive tracts and becomes concentrated in animal droppings and urine. Do not substitute the fluorescent powder designed for day use.
3. Bird seed, peanut butter, hamburger or other possible foods for animals.
4. Plastic cup with cover, or plastic bag to carry bait in the field.
5. Optional material: This activity can be carried out by noting the differences in size and kinds of droppings or by observing the animals. However, if you wish further identification of specific droppings, you may wish to obtain O. J. Murie's *A Field Guide to Animal Tracks* (A Peterson Field Guide).

Note: The fluorescent lamp is available from most outdoor, camping, hardware, and discount stores under the name *Safari Lamp*. The blacklight bulb and fluorescent tracing powder may be purchased from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

PREPARATION

This activity requires two night observations. No other advance preparation is necessary.

Weather Note:
This activity can be successful in rain and snow, as well as fair weather.

ACTION

1. Treat the baits by mixing one part fluorescent tracing powder to four parts bait. Put this bait into a small covered container or plastic bag that is easy to carry in the field.
2. Select one or more bait stations (any spot in your area where you decide to place bait).
3. Put ¼ cup of the bait at each bait station.

   For best results: leave bait in the field for one night before making observations.
4. After dark, with the aid of the blacklight, follow the animal trails made by fluorescent powder from the animal's feet, urine and droppings.
5. Observations should be made on more than one night. Replenish the bait when necessary.

WHAT DO YOU THINK?

1. How can you determine if the evidence you found was made only by night-time animals?
2. How many kinds of animals came to your bait-station(s)?

   How can you determine the number of kinds?
3. Is one kind of animal more abundant?
4. Where are the favorite trails of the animals in your area?
5. What influence do you have on the animals of the area when you put out bait-stations?

WHO GOES THERE?

Discovering Night Animals

FOLLOW UP

Place bait in two distinct vegetation areas (meadow or forest, shrub or grassy openings). Which area seems to have more mammal activity around the bait stations? What could be some of the reasons for a greater number of mammals in one area than another?

WHAT TO DO NEXT

Habitat Sun Prints
Natural Recycling in Soil
Sticklers

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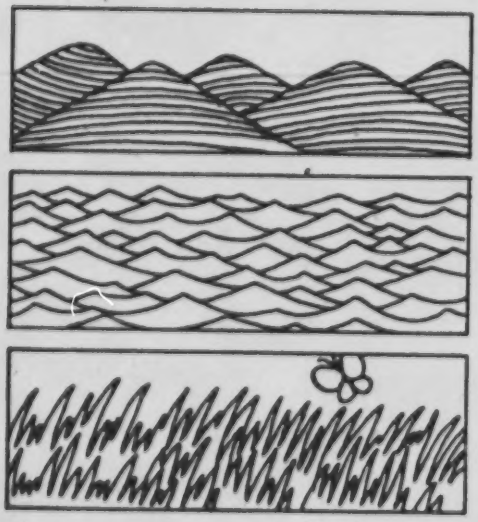

USING THE OBIS FOLIOS

Each OBIS folio can provide an enjoyable and interesting outdoor activity. You can either select individual activity folios for inclusion in your existing environmental program or a group of folios to provide a comprehensive experience in outdoor biology. Flexibility and adaptability in selection and use of activities are major aspects of the design of the OBIS materials.

OBIS activities are intended primarily for boys and girls between the ages of ten and fifteen, but have been used successfully with both older and younger individuals. With some assistance, older participants can often take on a leadership role in guiding small groups using the folios.

In the "Currently Available OBIS Folios" section, you will find a list of the available folios. A'so indicated is the habitat or habitats in which each activity has proved useful.

CURRENTLY AVAILABLE OBIS FOLIOS

Adaptation – Predator-Prey (All habitats)
Animal Movement in Water (All aquatic habitats)
Animals in a Grassland (Lawns, meadows, and fields)
Attention! (All habitats)
Bean Bugs (All terrestrial habitats)
Great Streamboat Race (Streams)
Habitat Sun Prints (All habitats)
Habitats of the Pond (Ponds and lakes)
How Many Organisms Live Here? (Ponds and lakes)
Invent a Plant (All habitats)
Invent an Animal (All habitats)
Mapping a Study Site (All habitats)
Moisture Makers (All terrestrial habitats)
Natural Recycling in Soil (All terrestrial habitats)
Natural Recycling in Water (All aquatic habitats)
Out of Control (Lawn)
Plant Hunt (All terrestrial habitats)
Plants Around a Building (Building sites)
Seed Dispersal (All habitats)
Sticklers (All terrestrial habitats)
Terrestrial Hi-Lo Hunt (All terrestrial habitats)
Water Holes to Mini-Ponds (All habitats)
What Lives Here? (All aquatic habitats)
Who Goes There? (All terrestrial habitats)

OBIS MODULES

The OBIS folios may be combined to produce concept packages, skill units, environment-oriented clusters, and many other schemes according to the needs of the children or the judgment of the leader. Any such grouping is often referred to as a **module**.

Combining several OBIS activities or folios into a module is best accomplished by the leader who knows the children, their ages, and their typical interest levels, as well as the available study sites, weather, time blocks, group size, and materials budget. Seashore activities obviously are not appropriate for a mountain camp site. Thus some selection is mandated by the physical site that is available. The leader is expected to match the level of the activities with the capability of the children. Many activities can be adapted to different age levels.

The OBIS development staff cannot foresee and provide for all possible variations in conditions. Therefore the individual leader is the most qualified individual to select and sequence the activities for his particular set of circumstances.

Some possible modules and the activities comprising the modules:

ADAPTATION

Adaptation – Predator-Prey
Invent a Plant
Invent an Animal
Seed Dispersal
Animal Movement in Water
Attention!

SAMPLING

Animals in a Grassland
Habitat Sun Prints
How Many Organisms Live Here?
Habitats of the Pond
Plant Hunt
Bean Bugs
Sticklers

POND

Mapping a Study Site
What Lives Here?
Habitats of the Pond
How Many Organisms Live Here?
Animal Movement in Water
Natural Recycling in Water
Water Holes to Mini-Ponds

SAFETY

The safety of your group is a prime consideration. In order to assure safety, OBIS designs equipment and procedures to be as safe as possible. In addition, OBIS recommends that leaders organize a "Buddy Safety System" when participants explore any aquatic or other potentially hazardous site.

The buddy safety system is designed so that no participant will ever be far from assistance should it be needed. Group members choose a "buddy" they would like to work with. For an odd-numbered group, organize one team of three buddies. When the youngsters are paired off, tell them that each individual is responsible at all times for the whereabouts and safety of his buddy. A participant should never leave his buddy unless his own safety is threatened. In the event of an accident to one buddy, the other should render assistance and call for help.

Avoid sites with obvious hazards such as steep banks and slide areas. Try to find a site with gently sloping banks for easy water access and unobstructed vision for easy supervision.

CONSERVATION — TAKE 'EM BACK ALIVE

Your youngsters should understand that no organisms should be permanently removed from their habitats. OBIS investigators collect organisms temporarily for observation and identification, but all should be returned to the exact place they were found (leaf samples are an occasional exception). The overall impact of your group on a study site should be minimal. Setting some rules of procedure would emphasize respect for the study site environment.

SITE SELECTION

Make sure your selected site is large enough for everyone to investigate without interference, but small enough to allow easy supervision of the group. Site boundaries should be clearly marked and the participants kept within the boundaries. An area fifty meters square is ample for most activities, while some activities can take place in even smaller sites.

Secure permission to use a site in advance if such permission is required. Familiarize yourself with any rules of procedure that apply to the use of the site. Some sites, particularly public nature areas, are protected by strict rules, particularly rules regarding interference with living organisms. Make sure the youngsters understand and follow the rules.

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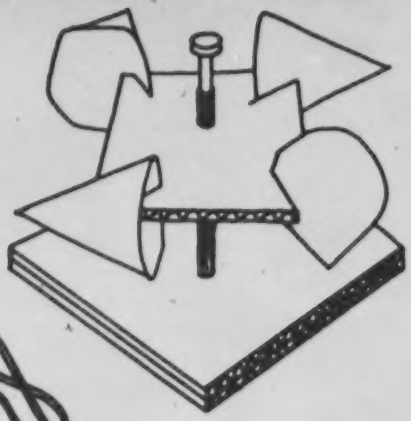

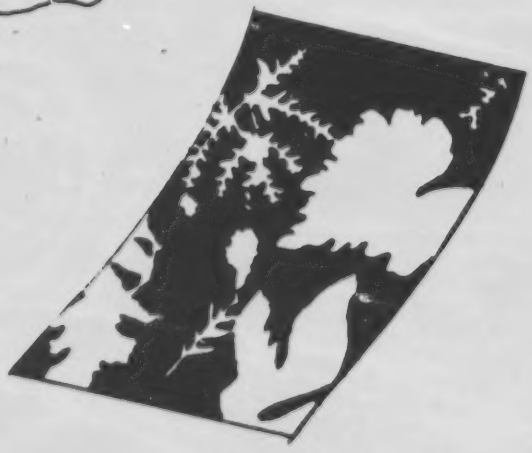

EQUIPMENT AND TECHNIQUE CARDS

Inserted in this folio you will find an assortment of equipment and technique cards. These cards give you instructions for building and using various pieces of equipment required for certain activities. A few of these cards may be used in more than one activity. You may make additional copies of any of the cards. The following is a list of the activities that require these equipment or technique cards.

Animal Movement in Water
Basic Aquatic Equipment

Animals in a Grassland
Sweepnet

Habitats of the Pond
Bottom Scrapers I and II
Basic Aquatic Equipment
Plankton Net
Weed Grapple

How Many Organisms Live Here?
Bottom Scrapers I and II
Basic Aquatic Equipment

Terrestrial Hi-Lo Hunt
Measuring Light
Measuring Slope
Measuring Wind Direction and Speed

Water Holes to Mini-Ponds
Basic Aquatic Equipment
Measuring Light

What Lives Here?
Basic Aquatic Equipment

BASIC EQUIPMENT, AIDS, GUIDES

Data Board

Many OBIS activities call for the use of a data board. This board serves as a portable blackboard, record board, map, and all-purpose data organizer. Because your participants probably will not have a desk or locker for storage of records from one investigation to the next, a data board allows you to maintain a continuing record. The data board relieves youngsters of the burden of pencils and notebooks; important terms can be easily viewed by all group members, and field observations are conveniently displayed in one place for group consideration.

Making a Data Board*

1. You will need a piece of thick cardboard, masonite, or fiberboard for a data board. A good size is 80 cm. x 60 cm.

2. Attach paper sheets (butcher or other) to the board.

3. Crayons or felt-tip markers are good for recording data because they leave broad marks and come in a variety of colors, allowing for easy color coding.

*As an alternative, you can use a large sketch pad or small blackboard.

Comparison of Data

Some OBIS activities require comparisons of data collected on different occasions, but at the same study site. It is often convenient to record the data on plastic overlays on a data-board map of the site. A good source of overlay plastic is inexpensive plastic dropcloth material sold at paint stores and discount variety stores (wax paper also works well). Data can be recorded on one overlay during one investigation, and on others at subsequent investigations. For comparison of data, simply stack up the overlays.

Lawn and Pond Organism Guides

These guides are designed for quick, easy identification of some of the most commonly encountered lawn and pond organisms. Only those organisms readily observed by the unaided eye or by means of a simple magnifying lens have been included.

To use the guides, simply flip through the pages until you come to a drawing that corresponds to the organism you wish to identify. Use the size scales or scale-size drawings and the text to verify the organism's identity. Since the drawings are black and white and do not move, be sure to explain to your group that the organisms located will not exactly match the guide's drawings. The investigator should look for the drawing that most closely resembles his organism.

Action Cards

Many folios contain activity cards which must be duplicated in order to provide sufficient copies for the youngsters. These cards, and in some cases the equipment cards, may be duplicated on any copying machine and the master sheet saved for future activities. We suggest you do the copying before the activity period and, in the case of summer camps or wilderness situations, before leaving the office machine behind.

Each sheet of action cards contains four cards; cut the copies apart and give one card to each participant. In some cases, we provide blank cards which allow you to create additional experiences that are suited to your particular environment.

Equipment Card
BASIC
AQUATIC EQUIPMENT

Outdoor Biology Instructional Strategies

Bug Boxes. A bug box is a small, clear plastic box with a magnifying lens for a lid. To use, place an object or organism in the box and replace the lid to magnify the contents. A closed bug box heats up rapidly (especially when it is exposed to direct sunlight), so release organisms promptly after observing them.

Hand or Dip Nets. Hand nets can either be made or bought (aquarium nets work fine). You may want to extend the reach of an aquarium net by attaching some dowling or similar extension to the handle. A gradual, gentle scoop of the net is usually more successful and less damaging to organisms than a sudden, violent scooping motion. To prevent eye accidents, ask that the nets never be raised higher than shoulder level.

Magnifying Lenses. Magnifying lenses (5x to 10x, plastic or glass) must be purchased or brought by members of the group. To use, hold the lens close to one eye and move either your head or the object back and forth until you can see the object clearly.

Meter Sticks. A meter stick is useful for measuring water level variation in the water holes. Carry a meter stick each time you visit the water holes or fix a short ruler or other gauge in the water holes for direct readings.

Spoons and Clear Plastic Cups. These are useful for transporting tiny organisms and observing them at close range. Simply dip up tiny organisms with a spoon and place them in a cup partially filled with clear water.

Team Site Boundary Markers. Each investigating team will need two markers to indicate the boundaries of its study site. You can make these from 3" by 5" index cards. Staple, glue or tape the cards to sticks approximately 18" long to make a small flag. Make the boundary markers beforehand so trees and small shrubs need not serve as marker supports.

Thermometers. An ordinary thermometer can be used to monitor air and water temperatures. For safety and durability, choose an alcohol (red indicator) thermometer with a plastic or aluminum backing.

White-Bottomed Containers. These containers, which serve as observation pans, must be purchased or brought from home (white dishpans work well). The white bottom makes it easier to spot organisms living on the plants, and in the mud and debris of the pond bottom. You can also use these containers to temporarily hold an organism for observation. Merely dump dredged-up plants or mud and debris from the pond into the pan and examine the pieces one-by-one for eggs, animals, and other pond life.

Note: Certain hard-to-get materials are available from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

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Equipment Card
BOTTOM SCRAPER I

A **bottom scraper** is used to bring up a sample of bottom mud and debris for close examination. It can be used in shallow or deep water, provided a tow line of sufficient length is used to keep the scraper traveling along the bottom. This device allows you to closely observe organisms which you would otherwise completely overlook. To build your own bottom scraper you will need:

1 Empty can (any size will do)

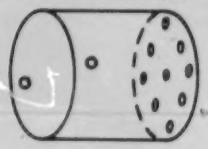
1 Piece of #18 or #20 wire 5 cm. longer than the diameter of the can

1 8 oz. fishing weight, or other convenient weight

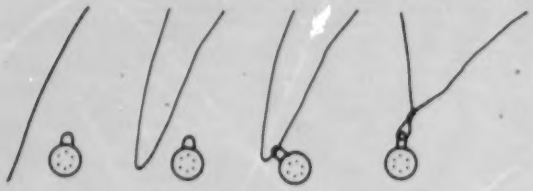
1 Nail and hammer to make holes on the bottom of the can

1 Tow line

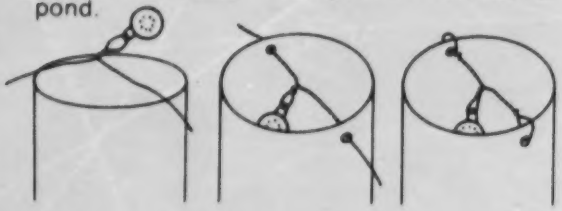
1. Punch holes in the can: several in the bottom, and two holes on the side of the can near the top, one directly across from the other.



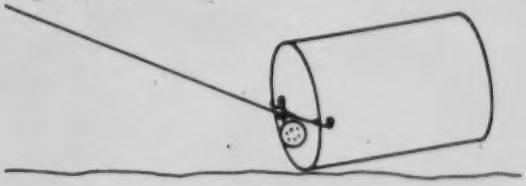
2. Now fasten the fishing weight (8 oz.) to the center of the wire with a few twists. If you twist the wire so that a big eye hole remains, you will have a convenient place to attach a tow line.



3. Now assemble the two parts by passing the two ends of the wire through the two holes you punched at the top, center the weight in the middle of the opening of the can, and twist the ends of the wire securely. Tie on the tow line and you are ready to sample the bottom of a pond.



4. To use the scraper, toss it underhand into the water and slowly pull it in. Filter the contents through a net or sieve to separate organisms.



BOTTOM SCRAPER II

A **bottom scraper** that works well with firm or plant-covered bottoms can be made by bolting or nailing a fruit juice can (no. 10) to a wooden dowel or broomstick. The mouth of the can should point toward the user's end of the pole. Use the scraper as you would a rake to sample the bottom. To make this scraper you will need:

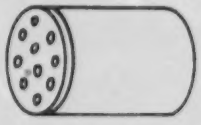
1 #10 empty can

1 Pole (a meter long)

1 Hammer

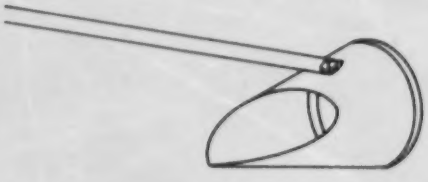
Screws or bolts (or nails)

1. Punch several holes in the bottom of the can.



2. Flatten one side of the mouth of the can to make a broader scooping surface.

3. Bolt the stick to the upper half of the outside of the can at an angle to the long axis of the can (as illustrated). Your bottom scraper is now ready to scrape the pond bottom for samples.



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Equipment Card
Measuring Light

MATERIALS FOR LIGHT MEASURING STATION

1 package of proof paper (Studio Proof F, Kodak)
1 small jar of photographic hypo (fixing solution): mix 1 tablespoon of crystal for each cup of water.
1 small jar of plain water
1 pair of forceps or tweezers for transferring the pieces from the fixer into the water and onto the cardboard.
1 piece of cardboard (approximately 40 cm. square)
some pins or tapes
1 watch or kitchen timer

Note: Certain hard-to-get materials, such as the proof paper, are available from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

How to use OBIS Proof Paper Light Meter:

Print-out paper (Studio Proof F, Kodak) can be used to measure light intensity. A five minute exposure time will turn a piece of white proof paper dark brown when exposed to direct sunlight, light brown when exposed to filtered light (shade or overcast), and white to light tan when exposed to deep shade or artificial light. You can halt the color change by dipping the papers into photographic hypo (fixing solution) for a few seconds and then washing them in plain water for a few seconds. The fixed pieces can be dried by pinning them on a piece of cardboard.

A standard sheet of proof paper will suffice for 16 field exposures; simply cut the sheet into 16 pieces. Cut the sheets indoors and keep them in light-proof packages until you are ready to use them. To use proof paper, simply remove a piece, write the location of exposure on the back of the piece, expose it for five minutes, fix and wash it, and pin it up to dry. Proof paper is insensitive enough to allow for small time delays and exposure errors.

To use proof paper underwater, you will have to use a transparent, waterproof housing like a glass jar with a waxed lid, or several plastic bags placed one within the other and sealed with rubber bands. Attach the proof paper to a small piece of cardboard and weight the jar or bags so that the proof paper faces the surface when it's submerged.

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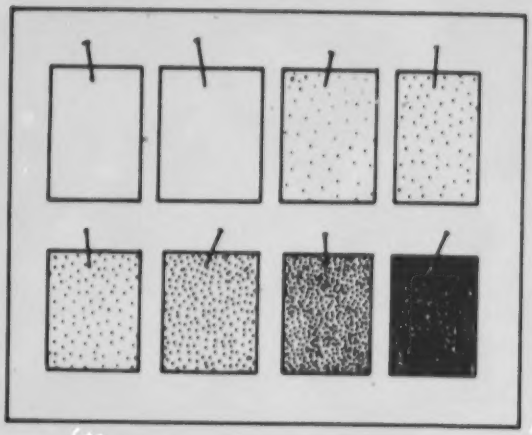
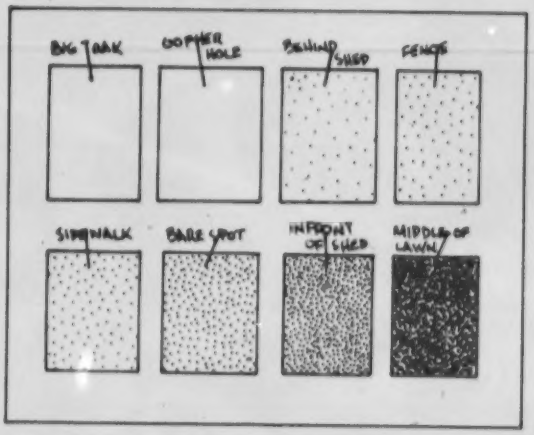
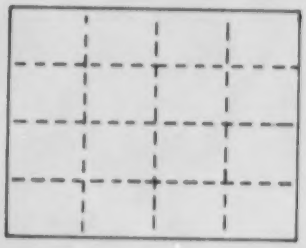
For Water Holes to Mini-Ponds



For Terrestrial Hi-Lo Hunt



Write the location of the exposure above each piece of paper after pinning it on the drying board.



Equipment Card

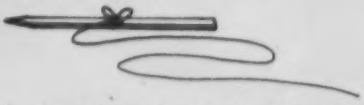
Measuring Slope

MATERIALS FOR SLOPE-MEASURING DEVICE

1 meter stick
1 125 cm. piece of strong cord
1 25 cm. sharpened stick
1 level tube (test tube and cork)*
household ammonia
water
tape

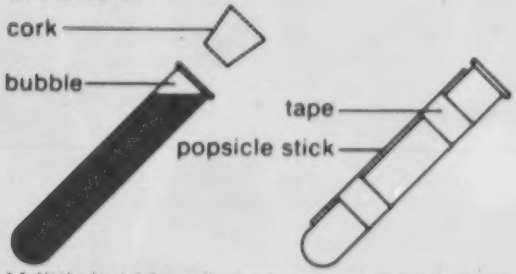
Slope can be determined by fixing an anchor point at the upper part of the slope, drawing the one meter cord taut, sliding it up or down until the cord is level, and reading slope directly in cm/meter. Assemble the apparatus like this:

1. Sharpen the 25 cm. stick and fasten the cord to it with a knot which can slide up and down the stick.



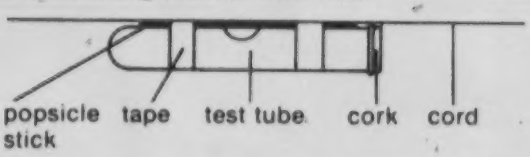
2. Attach the free end of the cord to the meter stick so that the distance between the two sticks is one meter, and the cord can slide on the meter stick. You can mark off centimeters on any stick if you do not have a meter stick.

3. Make your level. Fill the test tube almost full of water and add a drop of ammonia. Cork the tube so that a small bubble remains. Trim off top of cork. If your test tube has a flared lip at the top, tape a popsicle stick to the side of the tube before taping the level tube to the center of the cord.

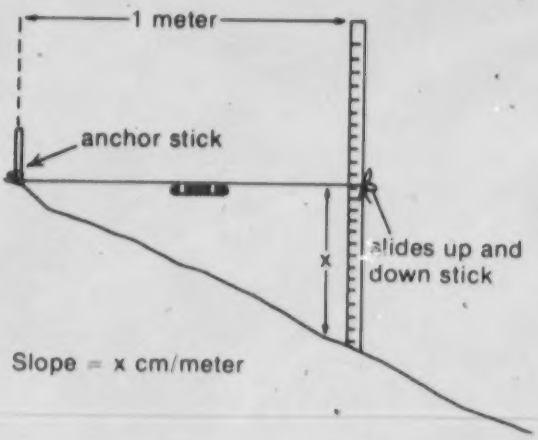


*A little bubble called a line level is available at hardware stores or may be purchased from the Lawrence Hall of Science. See the order form in the *OBIS Toolbox* folio.

Your level should look like this:



4. Assemble all pieces and use like this:



Slope = x cm/meter

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Equipment Card
PLANKTON NET

Outdoor Biology Instructional Strategies

A **plankton net** is a device for concentrating minute aquatic organisms for close observation. These organisms are easily overlooked in water samples and pass through standard dip nets. The plankton net is essentially a cloth funnel which allows water to pass through but retains small organisms. The small organisms collected in the funnel are washed down into the clear vial at the bottom of the funnel. To make a plankton net you will need:

1 Metal embroidery hoop (about 15 cm. in diameter)

1 Piece of old bed sheet

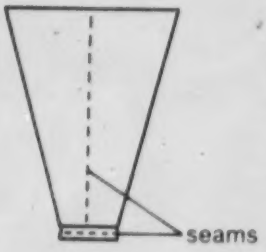
1 7 dram (approximate size) vial (old pill vials are fine)

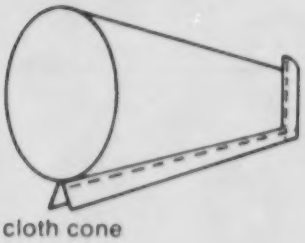
2 Pieces of #20 wire, each 10 cm. longer than the diameter of your hoop

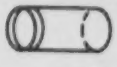
1 Tow line (about 6 meters long)

1 Rubber band

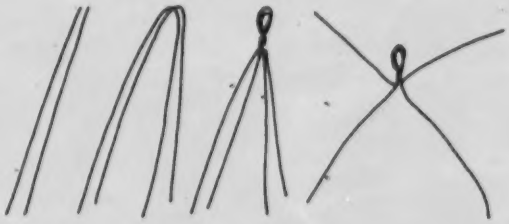
1. Sew the cloth cone.
The net is a cone of old bed sheet material as wide at the top as your embroidery hoop, and as narrow at the bottom as your vial. A couple of measurements and a trial or two should be sufficient to give a suitable pattern from which any number of nets can be made. Two seams are needed: one at the vial end to keep the material from unraveling, and one up the side to make a cone.





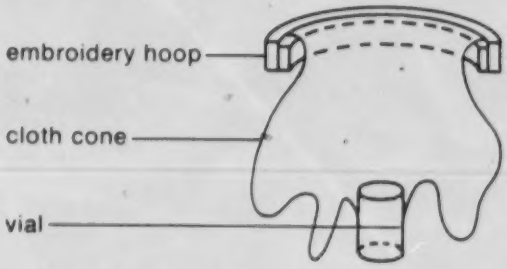


2. Prepare the wire yoke
Using a pair of pliers, if necessary, twist the two wires together as shown. Be sure to leave an eye at the center to attach your tow line.

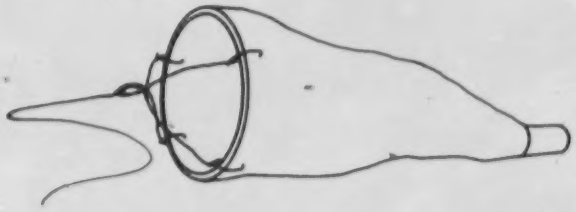


3. Assemble your net.
Fix the net in the embroidery hoop. Any way that will work is good, but this way is the best:

Cross-section of Plankton Net



Attach the wire yoke to the hoop-net combination by pushing the wire through the cloth and twisting each wire around the hoop.



Drop the vial in from the open end and secure it with a rubber band. Attach a tow line to the eye of the yoke, and your net is ready.

4. To use a plankton net, toss it underhand into the water and either pull it in hand-over-hand, or pull it out by moving away from the pond. Make five or more passes to concentrate the surface life before examining the plastic holding vial.

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Equipment Card
SWEEPNET

Animals in a Grassland

Outdoor Biology Instructional Strategies

MATERIALS:

1 wire coat hanger

1 stick (approximately 1 meter long) for your net handle

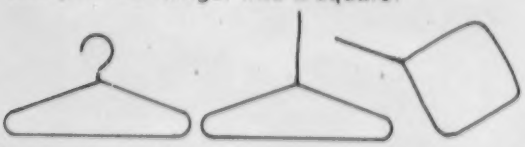
1 piece of cheese cloth or netting for the net bag (1 square meter)

1 needle and thread for sewing (or a sewing machine)

1 piece of tape or wire to attach net to handle

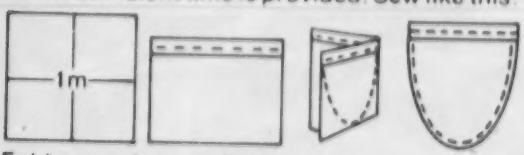
1. Preparing the hoop.

Take a wire coat hanger, straighten the hook, and pull the hanger into a square:



2. Preparing the bag.

Your net should be approximately one meter in circumference at the top, tapering down to a point. A sewing machine speeds up construction, but older kids can hand sew the nets if sufficient time is provided. Sew like this:



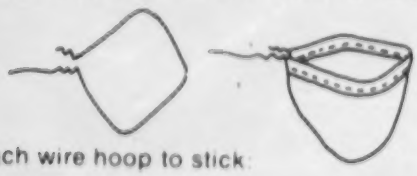
Fold one edge down and sew

Fold square in half and sew

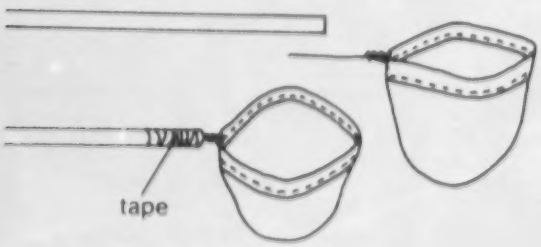
Cut off excess

3. Assembling the net.

Open the wire square and thread on the net:



Attach wire hoop to stick:

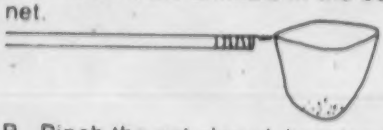


4. Using a sweepnet.

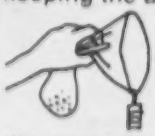
While a sweepnet can be used to pursue and capture an animal that has caught your eye, this is not the most efficient method of use. A sweepnet is best used as a random sampling tool. You walk at moderate speed across the grassy area, sweeping the net back and forth, in pendulum fashion, in front of you. The net should just brush across the top of the grass. The idea is to sweep any animals that are buzzing around in front of you into the nets, so you must turn the net in your hand to capture animals on both right and left swings of the net. After you have made fifteen to thirty swings of the net, make a quick swing around your head to concentrate the animals at the bottom of the net, and grab the end of the net in your hand to keep the catch from escaping.

How to transfer animals from net to observation bag:

A. Concentrate animals in the bottom of the net.

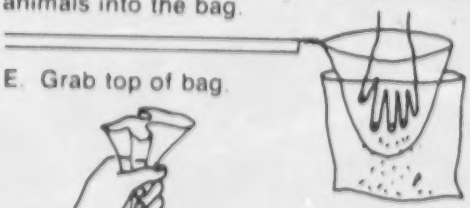


B. Pinch the net closed, keeping the animals in the bottom of the net.



C. Turn net inside out while holding animals.

D. Place net in plastic bag, release and shake animals into the bag.



E. Grab top of bag.

F. Twist the top a couple of times and tuck the top under your belt or into an open pocket while you continue to sweep.

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Equipment Card
WEED GRAPPLE

Outdoor Biology Instructional Strategies

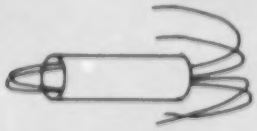
Submerged plants and other debris not easily reached from shore can be collected by using a **weed grapple** fashioned from a short piece of pipe, coat hangers, and a long line. When using the weed grapple, be careful to use a low, underhand toss to avoid hitting another person. Always remember to hold on to the free end of the tow line when you toss the weed grapple, so that it will not be lost. To make a weed grapple, you will need:

1 6 to 8 cm. length of pipe, 1 to 2 cm. in diameter
2 Coat hangers
1 Tow line
1 Pair of pliers for bending the coat hangers into shape

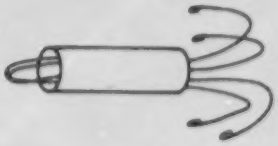
1. Separate or bend the two coat hangers into two long pieces of equal length.

2. Bend the wires in half and insert both of them into the pipe so that the bent ends stick out a little from one end of the pipe. The tow line will be attached to these loops.

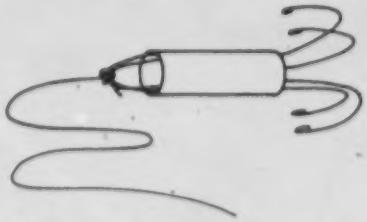
3. Bend the unlooped ends of the coat hanger lengths to form a four-pronged hook at the other end.



4. Bend the end of each hook back, so there will be no sharp ends exposed.



5. Attach the tow line to the bent hanger loops, and your weed grapple is finished.



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Equipment Card
MEASURING WIND DIRECTION AND SPEED

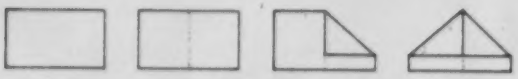
Outdoor Biology Instructional Strategies

MATERIALS FOR ONE WIND STATION:

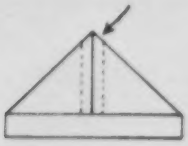
2 nails (16 penny)
1 or 2 cardboard bases (three thicknesses of cardboard glued together, at least 10 cm. by 10 cm.)
2 pieces of plastic soda straw (6 cm. long)
1 piece of heavy duty aluminum foil (15 cm. by 2 cm.)
1 roll scotch tape
1 magnetic compass
1 pair of scissors
1 marking pen
1 tube of glue
1 watch with second hand
4 3" x 5" index cards
1 stapler
1 square of cardboard (6 cm. by 6 cm.)

CONSTRUCTION OF WIND SPEED MEASURER

1. Make 4 cones as follows:
   Take a 3" x 5" card and fold it like this:



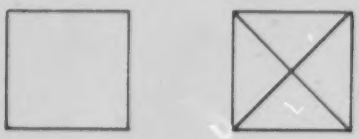
Tape it here with scotch tape:



Cut on a curve like this:

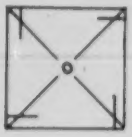
Open the cone, and make three more.

2. Construct your cone holder as follows:
   Cut 6 cm. cardboard square and draw two diagonal lines.

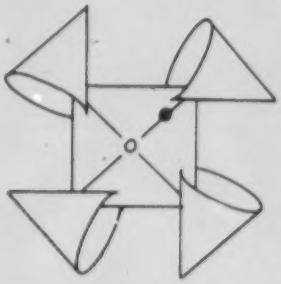


Where the two diagonals intersect, poke a hole with your nail and enlarge it until your straw segment fits snugly in the hole.

Cut four slots in the cone holder like this (cut in 1-2 centimeters):



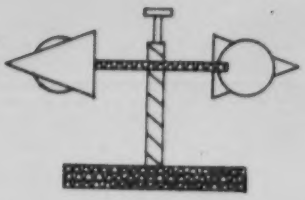
3. Assemble the apparatus:
   Slide a cone into each slot. Be sure they all face the same direction (clockwise or counterclockwise).



Put a reference mark on the cone holder near one of the cones to help you count revolutions.

Make your base by gluing three thicknesses of cardboard together.

Run a nail through the straw and stab it into the cardboard base.

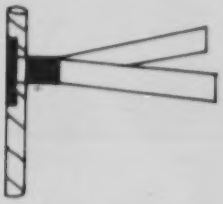


You may want to put a small washer here if you have one.

CONSTRUCTION OF WIND VANE
(for measuring wind direction)

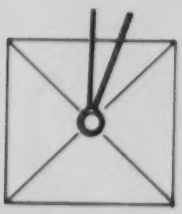
1. Cut a piece of heavy-duty aluminum foil 15 cm. by 2 cm. Bend this around the second 6 cm. piece of straw.

2. Fold the pieces of aluminum foil tightly together and tape them near the straw.

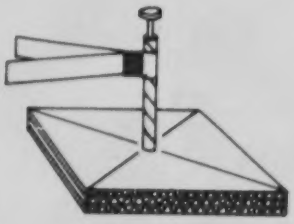


Slap a little piece of tape here to keep the aluminum foil from sliding up and down the straw.

3. Put a nail (small enough to allow the straw to rotate) through the straw and push it into a cardboard base (same as the wind speed measurer or a different base). Spread the two pieces of aluminum foil slightly, and you are ready.



top view



side view

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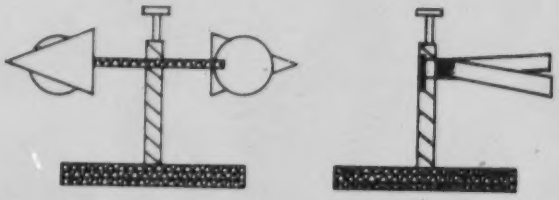
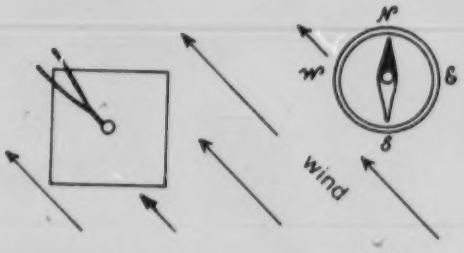
USING YOUR WIND STATION

With these two pieces of equipment you can measure direction and speed of wind.



Wind direction is measured with your wind vane. Place it in the wind and note the direction the aluminum foil swings. Winds are named for the direction they come *from*. A wind blowing *from* the north is a north wind. You will want to use a compass if you have one to help you determine directions. This is a south-east wind:



Wind speed is determined using an anemometer (the gadget with the four paper cones). The faster the wind blows, the faster the device turns. Wind speeds should be reported in revolutions per minute. (You will need a watch with a sweep second hand.) Set the wind speed meter in the location that you want to measure wind speed, get the watch ready, and holler "Go!"). One person watches the second hand while the other counts how many times the colored cone goes by. After a minute (or fraction of a minute), the clock watcher hollers "Stop!" and the other reports how many times the colored cone went by. Wind speed in a calm area might be 6 or 7 revolutions per minute (rpm) while fast wind might be in excess of 100 rpm's.

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POND GUIDE

POND GUIDE

A guide for identifying organisms
found in and around the pond.

Trial Edition August 1978

Outdoor Biology Instructional Strategies
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PREFACE

OBIS is an NSF-supported project that is currently developing outdoor biology instructional activities for familiar, man-managed communities such as lawns, ponds, streams, farms, and gardens. These activities are being designed for young people 10 to 15 years of age.

This guide was written as part of the OBIS activities for the pond. It is designed for quick, easy identification of some of the most commonly encountered pond organisms. Only those organisms readily observed by the unaided eye, or by means of a simple magnifying lens, have been included.

References are listed at the end of the guide. Both the artist and the author express their gratitude to the authors of the consulted works. Those desiring more information about pond organisms would do well to refer to these publications.

Note: This guide was produced as an aid to the study and appreciation of pond life. We ask the users of this guide to leave the ponds and other freshwater systems they study as they found them so that others who follow may find the same pleasure in the sites.

WHERE TO USE THIS GUIDE

This is a guide to common aquatic organisms in ponds. If you do not have a pond nearby, try a forgotten bucket of water, a puddle, a quiet stream, or an edge of a lake or reservoir. While you may not be able to find the exact plant or animal described in the guide, you may find the general type.

When plants and animals can't be easily observed, a net or plastic bag on a pole will help you locate and catch them. Try to observe organisms in their natural settings; if you have to take the organism out to look at it, be sure to replace it when you've finished your examination. Placing animals in a plastic bag filled with water is a good way to observe them. A hand lens is also useful in your work.

HOW TO USE THIS GUIDE

The animal section has been organized by major groups or phyla. In some cases (Arthropods, for instance), groups have been broken down further.

The plant section has been organized by growing zones (i.e., shore, emergent, floating leaved and submerged plants).

The small size of the guide lends itself to page flipping until the desired illustration is located. The brief text can then be checked to verify the identification.

Size scales have been included with some animals as an aid to identification. The size scales represent the minimum and maximum body lengths of all the members of a particular order (leeches) or family (damselflies) of animals. Antennae and tail parts have not been included in these scales. For most of the smaller animals a scale size drawing has been included along with the illustrations.

ACTIVITIES TO DO WITH THIS GUIDE

You can identify many plants and animals in the pond with this guide, and you can do much more...

Find and identify a plant or an animal in the pond.

Can you find an animal or plant similar to the one you just identified?

Can you find the same animal or plant in another color?

Can you find the same animals active throughout the day?

Are there animals that are active only early in the morning or only in the evening?

How do the plants change during the day? (Pick out one plant and make hourly observations of it.) Is the flower open or closed? Which way do the leaves face? Is the plant wilted? Are there insects on it?

Wait three months. Can you find the same plants and animals you found before? Are there any new plants or animals?

Can you find a larva? What does it turn into? (Hint: leave the larva where you found it and make periodic observations until it hatches. Did you guess right?)

Can you find animals that have immature forms that do not look like the adult forms? Can you find ones where both adult and immature forms are similar? Do the immature forms eat the same things that the adult forms eat?

Find a plant. Identify it in the guide. Is it found all over the area or in one certain spot? What are some of the conditions under which the plant seems to grow best?

Which plants and animals are the most numerous?

Which animals and plants can always be found in ponds?

What is one of the biggest changes that happens to your pond during a day? a week? a year?

These are just a few of the many observations and studies you can carry out in ponds. Try these activities, try some of your own, and have fun discovering the busy world of the pond.

Invertebrates

are animals without backbones. They comprise 95% of the animal kingdom as far as numbers of species are concerned. Includes coelenterates (i.e., jelly fish), worms and leeches, mollusks (i.e., clams), arthropods (crustaceans, arachnids, insects), echinoderms (i.e., starfish), and other miscellaneous animals.

COELENTERATA

means hollow gut and refers to the fact that the main cavity of the body is the digestive cavity. Includes hydras, jelly fish, sea anemones, and corals. Most coelenterates are marine.

hydras

have a stalk-like body with tentacles encircling the mouth. They look like a half-inch of string with the unattached end frayed out into several strands.

EARTHWORM GROUP

includes worms with segments. Segmented (divided into parts) worms appear to be ringed. The earthworms, leeches, and tubifex worms belong in this group.

Leeches

are flattened, ringed worms that have both a tail and mouth sucker. They feed on the blood of vertebrates and other invertebrates. Some species may reach over a foot in length.

Tubifex Worms

are slender, reddish worms that live in the soft bottom mud. They construct dirt tubes out of which only the hind part of their bodies is extended.

FLATWORMS

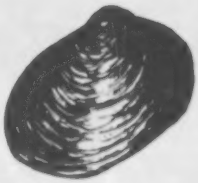
includes flattened, unsegmented (unringed) worms such as the familiar Planaria. Many flatworms appear cross-eyed.

MOLLUSKS

possess soft bodies and usually a shell. The mollusks contain mussles, clams, snails, slugs, squids, and the octopus.

clams and mussels

are distinguished by their bi-valved (clam-like) shells hinged at the back.



snails

usually have a single-coiled shell.

ARTHROPODS

are animals with jointed legs and segmented bodies. Includes crustaceans, arachnids, and insects.

Crustaceans

are primarily aquatic. They have an outer shell, or exoskeleton, and nearly all crustaceans breathe by means of gills.

crayfish

have five pairs of legs. The first pair is armed with claws. They look and behave like miniature lobsters.

scuds

have arched backs and narrow bodies and are shaped like fleas.

water fleas

are tiny crustaceans covered by a transparent shell. Their internal structure shows up very clearly under magnification. Their gut appears as a dark tube (j-shaped in Daphnia) running through the body length.

copepods

appear as little white specks darting through the water. They move in a jerky manner. Magnification shows them to be pear-shaped.

seed shrimp

are small crustaceans with bi-valved shells. They move by sticking their slender legs and antennae from between the shells and kicking them rapidly backward.

Arachnids

are members of the arthropod group with eight legs. Includes ticks, scorpions, spiders, and water mites.

10 spiders

have bodies divided into two segments: a head and an abdomen. The fisher spider is one of the few spiders that spends its life in or near water.

water mites

are usually no more than 0.2 inch long. Their bodies appear to be of one segment. They commonly appear as brightly colored spots swimming or walking about in the water.

Insects

are the most successful group of animals both in terms of numbers of species and total numbers. Adults have three body regions: head, thorax, and abdomen. The middle region (thorax) bears three pairs of jointed legs and the majority are equipped with one or two pairs of wings.

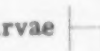
Trueflies

have only one pair of wings and include the mosquitoes, midges, craneflies, and houseflies.

mosquitoes

have one pair of transparent wings and most are equipped with a long piercing and sucking tube for obtaining their food. A hand lens reveals that mosquito wings are fringed with tiny, colorful scales and hairs. Only females suck blood.

mosquito larvae



are commonly called wrigglers because of their wriggling motion as they swim. Mosquito larvae appear hairier than midge or cranefly larvae. Wrigglers hang downward from the surface film and breathe by means of gills and an air tube.

mosquito pupae

look like large commas and move about using their flaplike tail parts. They usually last only a few days before the adult mosquito emerges.

midgeflies

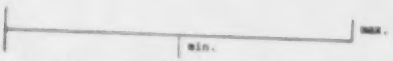
resemble mosquitoes but are usually smaller and more delicate. A hand lens shows their wings are bare and not covered with scales like the wings of mosquitoes.

midgfly larvae

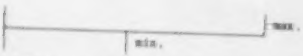
are slender and wormlike and many construct soft dirt cases around their bodies. Many midgeflies have larvae which are blood-red in color and are commonly called blood worms.

midgefly pupae

are also slender with a slightly enlarged head region. Midgefly pupae don't appear as hunched up as mosquito pupae.

craneflies 

look like giant mosquitoes. They are long and slender and their extremely long legs mark them as the "daddy-long legs" among flies.

cranefly larvae 

are larger than either mosquito or midgefly larvae. They are brownish to whitish and often appear quite transparent. True cranefly larvae have a breathing disk at the end of their tail.

cranefly pupae max. min.

are pale colored, sluggish, and do not eat. Most craneflies go to shore to pupate in soft, damp soil.

Water Bugs

have jointed mouth parts for piercing and sucking. Most have two pairs of wings. The young water bug nymphs look like smaller models of the adults with shorter wings.

backswimmers max. min.

are unique among aquatic bugs in the respect that they always swim on their backs. Their backs are shaped like the bottom of a boat and they use their long, hind legs to propel themselves through the water. Their bite is painful.

water boatmen max. min.

resemble backswimmers in shape but differ in that they swim on their stomachs and do not have a keeled underside. They propel themselves through the water with their long middle and hind legs.

water scorpions max. min.

have a breathing tube that is formed when they press their two, long, grooved tail filaments together. The water scorpion illustrated looks like an aquatic walking stick. The other type of water scorpion has a stout, oval-shaped body. Both types use their first pair of legs for seizing prey.

water striders max. min.

are named after their ability to rapidly skim or skate on their spiderlike legs over the surface of the water. They prefer quiet or gently flowing water. They range in size from the tiny broad-shouldered water striders with bodies about 1/8 inch long, to the large water striders with 3/4 inch long bodies.

giant water bugs

may reach 3 inches in length, making them the largest true bugs. They have wide, flat, oval bodies and can inflict a very painful bite. Their strong front legs are similar in form and action to the front legs of the water scorpions.

Beetles

make up one of the largest insect groups. They generally have four wings, but the thick, heavy, front pair serve as wing covers for the hind wings and as a protective back armor. Only a few species live in the water. Their larvae have three pairs of legs.

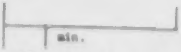
predaceous diving beetles

make up the major group of water beetles. They are usually observed with the tip of their abdomen at the water's surface and their head below the surface. They have an oval, flattened shape and their shiny compact bodies are generally colored black to brownish-black. Diving beetles have slender, thread-like antennae. Their larvae are commonly called water tigers.

whirligig beetles

are easily recognized from their whirling, circling motion on the surface. The smooth form of their oval, flattened bodies is broken only by their front legs which project from the sides of the body just behind the head. Their eyes are divided into two parts which allow them to see both above and below the water at the same time. They are blue-black or bronze in color.

scavenger beetles



resemble diving beetles but can be easily distinguished by their short, club-shaped antennae. They also differ from diving beetles in that they rest in a heads-up position when they are at the surface rather than head down.

14 Miscellaneous Insects

comprise those insects that do not fit in the three preceding categories.

butterflies and moths

have four wings that are covered with tiny, overlapping scales. The powder-like scales easily rub off when the wings are touched or handled.

butterflies

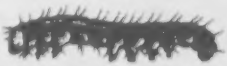
are generally slender-bodied, brightly colored insects. They have antennae that are swollen at the tips into lumps or knobs.

moths

are usually heavy bodied and dull colored. The easiest way to distinguish a moth from a butterfly is to look at its antennae. Moth antennae are variously shaped, but not clubbed.

butterfly and moth larvae

are commonly called caterpillars. They are wormlike but possess three pairs of legs near the head region and five pairs of leglike structures from the middle to the end of their bodies. Caterpillars have tremendous appetites and moult several times before changing into pupae.



butterfly and moth pupae

are usually compact, immobile structures that take no food. The pupa is a resting stage during which the insect reorganizes internally to form the adult.

dragonflies

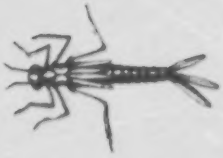
resemble short crayons with four large wings which are finely laced with veins. Dragonflies hold their wings in a horizontal position when resting.

dragonfly nymphs

are usually dull-colored, slow-moving organisms that use a scooplike lip to capture their food. The dragonfly nymphs are generally large and chunky in comparison to the damselfly.

damselflies

resemble matchsticks with four membranous wings. They are slimmer and more delicate-looking than dragonflies. Damselflies hold their wings close together and pointing backwards when resting.



damselfly nymphs

are slimmer and more delicate looking than the dragonfly nymphs. These nymphs have three leaf-shaped gills at the tips of their abdomen.

mayflies

are delicate-looking insects that possess two or three long, threadlike strands projecting from the tip of their abdomen and four nearly transparent wings. When resting, the wings are held close together and pointing vertically.

mayfly nymphs

are similar to damselfly nymphs but they appear stouter and their tail flaps are usually longer and featherlike. Mayfly nymphs also have smaller heads and lack a scooplike lip for capturing food.

caddisflies

are mothlike insects with four, soft, hairy wings and long slender antennae.

caddisfly larvae

live in little cases or tubes which they construct from pieces of wood, leaves, sand, and silk. Most caddisfly larvae build portable cases which they drag about whenever they travel. During travel only the front end of the body and the legs stick out from the case.

springtails

are tiny, wingless insects commonly found on the water's surface near shore. They are named after their unique forked tails that they keep folded beneath their body. When disturbed, the tail piece suddenly springs downward to lift the springtail up into the air.

Vertebrates

are animals with backbones. They comprise 5% of the animal kingdom. Includes fishes, amphibians, reptiles, birds, and mammals.

FISH

spend their lives entirely in water. Fish breathe by means of gills. They have fins and their streamlined bodies are usually covered with scales.

AMPHIBIANS

begin life in water with gills and later develop lungs. Their skin is thin, scaleless, smooth or warty, usually moist, and not waterproof. Frogs, toads, and salamanders belong in this group.

130

160

frogs

are smooth-skinned with long, powerful hind legs. Tree frogs have toes with enlarged tips.

toads

possess a warty skin, large neck glands, and are rarely found moving about during the day. Toads have shorter back legs than frogs.

tadpoles

are the well-known larval stage of frogs and toads. They are completely aquatic and do not possess external gills like salamander larvae.

salamanders

also include newts. They have a lizard-like body but lack claws. They have a moist, scale-less skin.

salamander larvae

are completely aquatic and possess external gills.

REPTILES

breathe by means of lungs. Their skin is dry, scaly, waterproof, and thick. Snakes, lizards, and turtles are familiar reptiles.

18 lizards

have movable eyelids and usually have limbs with clawed toes.

snakes

have no limbs and non-moving eyelids.

turtles

have a body shell into which they can draw their heads and limbs.

MAMMALS

have milk glands for nursing their young and at some time in their lives possess hair or fur. Most mammals are more active at night (nocturnal) than during the day (diurnal).

raccoons

are easily identified by his black mask and black-ringed tail. Look for his handlike tracks along muddy shores and stream banks.

deer

are large, browsing mammals. Males start to grow antlers in the spring and shed them each year in late winter.

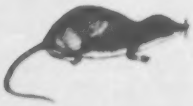
mice

are small, gnawing mammals. Usually one obtains just a glimpse of these small animals as they dart away. The house mouse came to America from Europe as a stowaway on early ships.

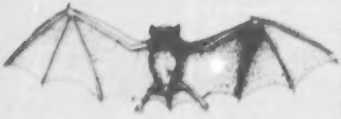
muskrats

are ratlike but chunkier with a thick, naked tail. They are good swimmers.

shrews



are the smallest, living mammals. The pygmy shrew may weigh less than a tenth of an ounce when full grown. Mouse size or smaller, shrews are distinguished by a pointed snout, pinpoint eyes, and tiny ears.

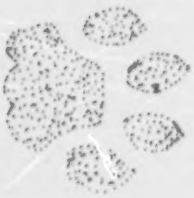


bats

are familiar as the only true flying mammals. They possess great maneuvering ability and are often seen flying above lakes, ponds, rivers, and streams at dusk.

"tracks"

of dogs and cats may commonly be found around the edges of ponds and lakes.



Plants

SHORE

willows

prefer wet or moist soils and often grow near bodies of fresh water. They vary in size from small shrubs to large trees. Willows are easily identified by their narrow, pointed leaves.

horsetails

are fernlike plants that often grow near the edge of ponds and streams and in other moist areas. The successive whorls of side stems around the main stem gives the plant a shaggy, taillike appearance. Horsetails feel rough and abrasive because of their high silicon content.

sedges

are grasslike or rushlike plants. They often appear as spikes with grasslike leaves. Their stems are three-sided and appear triangular in cross section. They generally grow from 1 to 3 feet tall.

EMERGENT

cattails

are among the most familiar marsh and waterside plants. They grow 4 to 8 feet tall and new plants arise from their creeping root-stocks and seed. The seed clusters form the most characteristic feature of cattails, the dark brown cattail head.

spike rushes

are characterized by naked stems which are topped by a single flower or seed cluster. They usually grow in tight bunches and average from 2 to 5 feet in height.

bulrushes

include the familiar Tules. They may grow in water up to 9 feet deep; the Tule or great bulrush grows to a height of 15 to 20 feet. They usually appear as great spikes with a flower or seed cluster near their tips.

rushes

are similar to bulrushes but lack their size. Rushes average about 1 foot in height and usually have hollow stems. There are two forms; one is essentially a naked stem with a sheath at the base, the other bears flattened leaves along its stem. Like the bulrushes, the flowers and seed clusters are found near the top of the stem.

bur-reeds

are named after their closely packed seed clusters which resemble large burs. They are close relatives of cattails and are often found growing with them. Bur-reeds have long, slender flattened leaves like cattails and vary in height from 1 to 6 feet.

water plantain

grows close to pond edges and in other shallow, wet places. The pointed, oval leaves all arise from the base of the plant. The flower spray is supported on a long slender stem. The tiny flowers have three petals. Water plantain normally reaches 1 to 3 feet in height.

arrowheads

are named after their arrow-shaped leaves. Their three-petaled flowers are arranged in whorls of three on a long, slender stem. Arrowheads bear edible tubers or thickened roots which have given rise to such names as duck potato and delta potato. Arrowheads grow to 2 feet high.

water cress

is a sprawling herb that grows in moist to aquatic places. It was introduced from Europe and is often used in salads. Rooting occurs at the stem nodes or joints and in this manner water cress may spread to form dense stands in cold, spring-fed ponds and streams. It has compound leaves (two or more leaflets to a leaf) and white flowers which are borne on the stem tips.

165185

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mare's tail

belongs to the Milfoil family. It has hollow stems that may be partially or completely submerged. The narrow, short leaves are arranged on the stem in whorls of six to twelve leaves each. The stem varies from 10 to 18 inches in height and a line of stems often arise from a single, rope-like rootstock.

FLOATING

duckweed

is known as the smallest flowering plant. Duckweed has a tiny leaflike body which may or may not bear rootlets. The leaf-like plants float at the surface and often grow so densely they appear as a green carpet covering the surface of small ponds and ditches. Duckweed reproduces by breaking apart in addition to bearing seeds.

water ferns

are tiny floating ferns with scalelike, lobed leaves, and hanging roots. They often form dense reddish-green mats that can cover the entire surface of small ponds and ditches and shade out water plants beneath the surface. They reproduce by breaking apart; the broken fragments then grow into new plants.

water shamrocks

are amphibious ferns that are often found in shallow water of seasonally fluctuating depth. They are named after their clover-like leaflets. These leaflets are usually found floating on the water surface and are attached by long, slender stalks to a creeping stem rooted in the mud.

yellow pond lily

is one of the familiar water lilies. It is characterized by large floating heart-shaped leaves that are attached by long stems to the base of the plant rooted in the mud. The large, yellow flower is tuliplike and bears six to twelve petals. The stems vary from 4 to 15 inches long.

water shield

is similar to the pond lily with its long-stemmed floating leaf blades. The leaf blades are oval rather than heart-shaped, however, and the reddish-purple flower is far from tuliplike and appears only briefly. The stems range from 1 to 4 feet in length.

water milfoils

have stout stems that vary from 1-1/2 to 3 feet long and bear leaves in whorls of three to six. The milfoils may be partially or completely submerged. The submerged leaves differ in size and shape from the leaves that are above the water. The milfoils' tiny flowers grow near the stem tips.

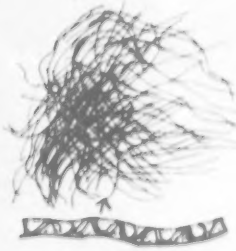
aquatic buttercup

bears the characteristic yellow or white buttercup flower with five petals. Submerged leaves are finely divided as opposed to the three-lobed floating leaves. The submerged plant stems appear whitish.

SUBMERGED

bladderworts

have long slender stems that may be submerged or floating. The stems bear leaves that are so finely branched they look like a capillary system. To the finely branched leaf segments are attached the bladder-like traps that give the plants their name. The tiny bladders are effective in trapping minute water animals.



filamentous algae

belong to the green algae group which is more abundant in ponds and lakes than all the alga groups combined. Filamentous algae appear as very thin green strands that often form dense submerged mats.

elodea

or Anacharis grows entirely submerged as a loosely rooted or free-floating plant. The branched stems are crowded with green, translucent, narrow leaves arranged in whorls of three or more. Elodea spreads with amazing speed and may literally fill up a pond or slow stream and crowd out other plants.

hornwort

is also known as coon tail because of the dense whorls of leaves arranged about the stems. The narrow, forked leaves bear small teeth or horns along their margin. Hornwort has no true roots and its tiny flowers are fertilized underwater.

pondweeds

make up the largest group of truly aquatic seed plants. All of them grow rooted to the bottom and most grow completely submerged except for their flowers. The group shows a wide variation in leaf shape and size. Many pondweeds have long underground stems and tubers that give rise to new plants. The pondweed illustrated is one of about forty species.

water nymphs

appear as slender, many-branched plants that grow completely submerged. They have leaves that bear a characteristic serrated or toothed margin. The leaves broaden abruptly at their base. The flowers and seeds are found inside the leaf bases.

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LAWN GUIDE

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LAWN GUIDE

A guide for identifying organisms
found in and around the lawn.

Trial Edition August 1978

Outdoor Biology Instructional Strategies
Lawrence Hall of Science
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Berkeley, California 94720

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PREFACE

OBIS is an NSF-supported project that is currently developing outdoor biology instructional activities for familiar, man-managed communities such as lawns, ponds, streams, farms and gardens. These activities are being designed for young people 10 to 15 years of age.

This guide was written as part of the OBIS activities for the lawn. It is designed for quick, easy identification of some of the most commonly encountered lawn organisms. Only those organisms readily observed by the unaided eye, or by means of a simple magnifying lens, have been included.

References are listed at the end of the guide. Both the artist and the author express their gratitude to the authors of the consulted works. Those desiring more information about lawn organisms would do well to refer to these publications.

WHERE TO USE THIS GUIDE

This is a guide to common plants and animals that can be found in and around lawns, pastures, vegetable or flower gardens, and vacant lots. You may not be able to find the exact plant or animal in this guide, but you may determine the general type.

Plants are easy to locate and closely examine because they do not run away. When you try to catch and observe any of the small animals in a lawn or garden, you may need to use a small net or plastic bag. A hand lens will help you in your observations. Do not collect the plants and animals; try to observe them in their original locations. If you must pick up the organisms, return them to the spot where you found them when you've finished looking at them.

HOW TO USE THIS GUIDE

The Lawn Guide is intended to be an easy reference for identifying organisms on the lawn. The organisms have been grouped according to general type.

There are two plant sections: Grass and Non-Grass. All the grasses have been shown with flowers, a situation rarely seen in regular lawn grasses. Except for weedy grasses which flower, it would be much too difficult to identify most of the lawn grasses. The Non-Grass plants are easy to identify, and many of the more common ones have been included in this guide.

For convenience, animals have been grouped in three sections. Small Flying Animals include those flying insects you will most often catch on or near the lawn. Small Non-Flying Animals include insects and other animals such as spiders, snails, and pill bugs. Big Animals include those most familair to you, such as birds, reptiles, and mammals.

Each organism is identified by a picture and a short description. Key descriptive words are underlined. In some cases, the picture of an animal is accompanied by a small drawing showing its actual size. The food habits for each animal are listed, and the length of each plant's life cycle is given. Less common terms are listed in the Glossary.

The small size of the guide lends itself to page-flipping until the right picture is found. The brief descriptions, particularly the underlined key words, can be checked to verify the identification and to find out about food habits or life cycle.

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ACTIVITIES TO DO WITH THIS GUIDE

You can identify many plants and animals in the lawn with this guide, and you can do much more...

Can you find an animal or plant on the lawn near your house that can also be found on the lawn of your school?

Can you find the same animal or plant in another color?

Can you find the same animals active throughout the day?

Are there animals that are active only early in the morning or only in the evening?

How do the plants change during the day? (Pick out one plant and make hourly observations of it.) Is the flower open or closed? Which way do the leaves face? Is the plant wilted? Are there insects on it?

Wait three months. Can you find the same plants and animals you found before? Are there any new plants or animals?

Can you find a larva? What does it turn into? (Hint: leave the larva where you found it and make periodic observations until it hatches. Did you guess right?)

Can you find animals that have immature forms that do not look like the adult forms? Can you find ones where both adult and immature forms are similar? Do the immature forms eat the same things that the adult forms eat?

Find a plant. Identify it in the guide. Is it found all over the area or in one certain spot? What are some of the conditions under which the plant seems to grow best?

Which plants and animals are the most numerous?

Which animals and plants can always be found in lawn areas?

What is one of the biggest changes that happens to your lawn during a day? a week? a year?

These are just a few of the many observations and studies you can carry out on lawn areas. Try these activities, try some of your own, and have fun discovering the busy world of the lawn.

Non-Grass Plants

Chickweed

Slender, much-branched stems with a line of white hairs along one side. Leaves smooth and pointed. Likes it cool. Annual.

Scarlet Pimpernel

Low growing. Stems branched. Most identifiable feature: under a clear sky salmon-colored small flowers are easily seen. Annual.

Dandelion

Almost stemless, with jagged leaves growing in a circle around the base of the plant. Flower stalks rise from the base. Easy-to-see yellow flowers turning into familiar puff-ball seed head. Annual, biennial, or perennial.

Sedge

Very narrow and stiff-leaved plant. Without its flower it looks very grass-like. Unmistakable flower stalk: little clusters of green flowers growing at the base of six spike-like leaves. Triangular stem, usually taller than lawn. Grows in very wet areas.

Moss

Small, short, soft stemmed plants. Many plants to a patch. No flowers. Found in over-watered lawns. Annual.

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Oxalis/Sourgrass

Looks like clover, but not related. Prefers shade. Grows low with runners. Flowers yellow, small. Stems taste sour. Perennial.

Knotweed/Knotgrass

Very low growing; forms circular mat. Found in areas with lots of foot traffic. Slender, wiry, non-rooting stems. Leaves bluish-green and smooth. Very small white flowers.

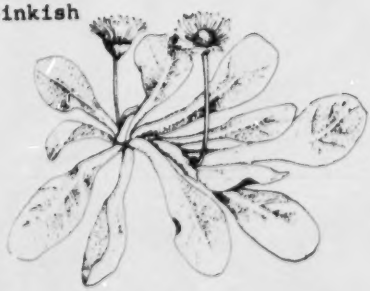
Mallow/Cheese Weed

Stems low and spreading. Leaves roundish and broad. Fruit looks like little rounds of cheese. Annual or often a biennial.

Spurge

Very low growing, stems form circular mats from single root. Stems and leaves are green or often reddish. Positive identification--pinched leaves yield a milky sap (poisonous). Annual.

English Daisy



Low growing with oval leaves. Flowers stick up. Easy-to-see white or pinkish daisy-like flowers. Perennial.

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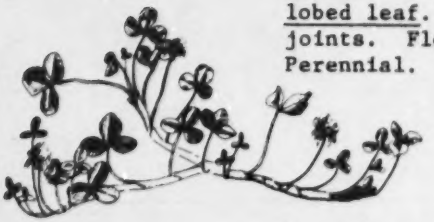
Clover



Common, non-grassy lawn plant. Three-lobed leaf. Low growing, roots at joints. Flowers white, red, or pink. Perennial.

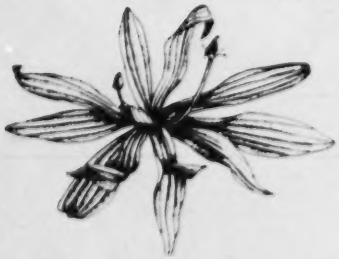
Burclover

Related to clover. Clover-like leaf. Stems are low growing and spreading. Flowers are small and yellow. Seed pod or "bur" is spiraled and spiny. Annual.

Broadleaf Plantain

Large, smooth, roundish leaves, 3 to 6 inches long. Flower stalks 3 to 6 inches long are easily seen sticking up from the plant's center. Perennial.

Narrowleaf Plantain/Buckhorn



Long, narrow leaves with parallel veins, 3 to 12 inches in length. Long flower stalks stick up above leaves. Perennial.

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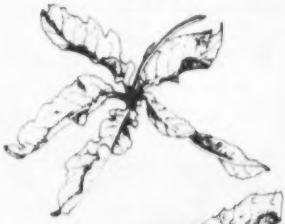
Thistle

Almost stemless, with leaves notched with long spines that hurt if touched at edges. Leaves are spiny and have short hairs and "pimples." Flowers, when present, are purplish. Perennial.

Curly Dock



Almost stemless, with large, reddish-green leaves that are curly and wavy along the edges, growing in a circle around the base of the plant. Flower stalks appear in the center of the plant and are green or reddish-brown in color. Perennial.

Bristly Oxtongue

Tallish. Coarse, rough-looking plant. Leaves covered with rough hairs and pimples. Flowers are yellow and look somewhat like small dandelion flowers. Biennial.

Dichondra

Low, creeping stems, root frequently at nodes. Can form dense mats, or even "lawns." Leaves lily-pad shaped; 1/4 to 1-1/2 inches in width. Flowers rarely seen. Perennial.

Cutleaf Geranium

Low growing, many branches per plant. Leaves are divided into narrow fingers. Easily seen small purple flowers. Annual.

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Grass Plants

Since grasses are easy to identify when they are in flower, and only weedy grasses usually flower in a regularly mowed lawn, most of the grasses listed are weedy species. Flowers are usually green, brown or beige.

Crabgrass

Fat leaves, yellowish-green in color, often hairy. Best way to tell is to look at flower. Spreads by seed and runners. Annual.

Bermuda Grass

Thick, coarse grass. Stems are smooth and wiry. Runners have many jointed parts with roots at each joint. Flower somewhat similar to crabgrass. Perennial.

Goosegrass

Low, thick mat-forming grass, growing from central point. Appears as a silvery, pale green clump. Will flower even under constant mowing. Distinctive flower. Annual or short-lived perennial.

Ryegrass

Long, narrow leaf, hard to tell from regular lawn grass unless flowering; somewhat glossier than most grasses. Forms clumps. Annual or short-lived perennial.

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Kentucky Bluegrass

Very common and desirable lawn grass. Can be identified in cut stage by looking with a hand lens at veins on upper side of leaf--look like railroad tracks running down the middle. Will flower along uncut edges of lawn; very tall, from one to two feet high. Perennial.

Annual Bluegrass

Short, soft, light-green grass. Will continue to form flowers and seeds even under frequent mowing. Usually found in cool, frequently watered areas. Look for light-colored flowers growing on short grass plants in lawn. Annual.

Foxtail/Wild Barley

Occurs as clumps, often in new or infrequently mowed lawns. The leaves are smooth, dull green. The mature seed heads look like a squirrel or fox tail, often sticking in socks or shoes.

Fungi

Mushrooms

Many kinds of fungi appear on lawns. Most are in the familiar toadstool shape. Others are button-like. They are usually white or light brown, but can range from bright red, blue, yellow to black. Many are poisonous. Mushrooms do not manufacture their own food, but live off decaying plant material.

Small Flying Animals

Dragonflies

Brightly-colored, fast-flying insects. Hard to catch. They have four large wings, which are held out when at rest, and a large head. Food: small flying insects.

Damselflies

Look like skinny dragonflies. Wings are held close together and point backwards when at rest. They are usually very brightly colored. Food: small flying insects.

Frit Flies (A)

Small black flies. Usually very numerous. Hover near lawn surface. Food: larvae feed on grass stems.

Houseflies

Several species of medium-large flies, all of which look something like the common housefly. The location of your lawn will determine the exact species. Stout-bodied, very active; single pair of wings. Food: scavengers on all sorts of decaying vegetable and animal waste matter.

Fungus Gnats (4)

Small, dark, mosquito-like, long-legged flies. With a hand lens you can see that the first segment of their legs is very long. Food: larvae feed on decaying vegetable matter and mushrooms; adults feed on the ooze from decomposing plant material.

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Marchflies

Small to medium-sized, clumsy, black flies can be very abundant in early spring and summer. Food: larvae feed on decaying vegetable matter and on the roots of plants.

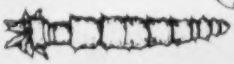
Mosquitoes

Skinny, long-legged small flies. Only one pair of wings, which are fringed with tiny scales and hairs (a hand lens is needed to see these). Most have long, piercing, sucking mouth parts. Food: females suck blood, males feed on nectar and plant juices.

Craneflies

Large mosquito-like fly, often orangish. Very clumsy and relatively common. Food: adults may feed on plant nectar or dew; larvae are scavengers or may feed on grass roots.

larva



Bees

Familiar honey bee with hairy, yellow and black striped abdomen. Usually found near or on clover, dandelion flowers, or other showy non-grass plant flowers. Food: pollen and nectar from flowers, nectar converted into honey back at hive.

Yellow Jackets

Very showy insects with bright black and yellow markings on its non-hairy abdomen. These wasps are pesty and will sting if disturbed. Food: scavengers, very noticeable during picnics.

Small Wasps

Any of a number of species of small, black, narrow-waisted wasps. Common in small numbers at all times of the year. Food: most are parasitic, laying their eggs into a host insect; the larvae feed on that host from the inside, eventually killing the host.

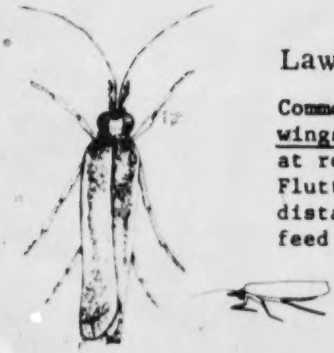
Butterflies

Slender-bodied insects with large, often brightly-colored wings. Wings are covered with tiny scales. Antennae are slender with a swollen knob at the end. Food: adults often don't feed--if they do, usually on flower nectars; larvae feed constantly on plant material.

Pictured here:

Monarch - black and orange
Cabbage - white and black

Typical larvae or caterpillar



Lawn Moth

Common slender moth. Long and narrow, wings usually folded against body when at rest. Very distinctive "snout." Flutter about at dawn; will fly short distance when disturbed. Food: larvae feed on stems or roots of grass.

Aphids

Small, round, soft-bodied insects. With wings at certain times of year, without wings the rest of the year. Usually green, can be black or brown. With a hand lens, can see tiny pegs sticking up from rear of abdomen. Food: adults and young suck plant juices.

Small Non-Flying Animals

Ladybug/Ladybird Beetles

Medium-sized, round, reddish-orange beetles with black spots (or reverse coloring). Often very common. Can be seen crawling to top of a blade of grass, flying a short distance, and repeating the action. Food: both adults and larvae are predators; favorite food is aphids.

larva

Beetles

Many types of beetles can be found on lawns; only the ladybird beetle is common enough to be specifically identified here. Beetles range in size from less than 1/8 inch long to 1 inch long. Pictured here are two kinds likely to turn up. A ground beetle and a little flea beetle. Beetles are all hard-bodied and rarely fly. Their wings are folded under their hardened backs. Food: some are predators, others are herbivores, still others are scavengers. Ground beetles are mostly predators, flea beetle adults feed on leaves, and the larvae feed on the roots of plants, particularly dichondra. Larvae often eat different food than adults.

larva

Weevils/Snout Beetles

As their name implies, these are beetle-like in appearance, with the head more or less elongated into a snout. Weevils, like beetles, prefer to run rather than fly. Food: almost all feed on plant material.

Earwigs

Slender, medium-sized insects with large pincers on the end of the abdomen. Earwigs are largely active at night and hide during the day in cracks, crevices, and under objects. Food: mainly scavengers, but also eat live plants.

Grasshoppers

Long-legged, jumping insects. Usually green or brown, they range in size from 1/4 inch to over 3 inches. Very large hind legs to aid in hopping, they also fly. Males sing by rubbing the inside of the hind leg against the lower edge of the front wing. Food: plant feeders

Leaf Hoppers

Small bugs, very numerous at certain times of year. Oval-shaped body, segments not well separated. Will move sideways, hop, or fly. Often interesting coloration: black, brown and white, or all green, some with red markings. Food: suck plant leaf juices.

Springtails

Tiny wingless insects that are very plentiful. They are named after their unique forked tails that they keep folded beneath their body. When disturbed, the tail springs downward, catapulting the insect into the air. May be dark-colored, yellowish, or colorless. Not likely to be caught with nets, but very likely found in traps. Very numerous in the soil. Hand lens is really needed to see them well. Food: scavengers, some feed on microscopic plants.

Ants

Small, black (sometimes red), narrow-waisted, ground-dwelling insects (rarely, winged ones can be found). Often found in large numbers, in swarms or lines. Antennae are usually elbowed. Familiar insect, lives in large colonies. Food: varied; some ants are predators, some herbivores, others scavengers.

Aphids

Small, round, soft-bodied insects. With wings at certain times of year, without wings the rest. Usually green, can be black or brown. With a hand lens, one can see tiny pegs sticking up from rear of abdomen. Food: adults and young suck plant juices.

Spiders

Many kinds of spiders can be found on lawns. All have eight legs, two body segments, and piercing mouth parts. Many spin webs to catch their prey; others, like the wolf spider pictured here, don't have webs but pounce on their victims. Food: all are predators.

Mites

Tiny spider-like animals; all adults have eight legs. Mites look like fast-moving dots. Colors vary; red, orange, brown, and black are most common. Food: varies; some are predators, others herbivores or scavengers.

Millipedes

Medium-sized, elongated, wormlike animals with many legs. Most millipedes have 30 or more pairs of legs, usually two pairs per segemnt. Often millipedes can be found rolled up into a ball. Food: most are scavengers.

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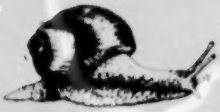
Centipedes

Medium-sized, elongated, flattened, worm-like animals with 15 or more pairs of legs. Each body segment has a single pair of legs. Very active and fast-running, unlike millipedes. Usually orange in color. Some will bite or sting if held in the hand. Food: predators.

Isopods/Pill Bugs/Sow Bugs

Medium-sized, oval-shaped, armored animals. Brown, black, or grey in color with yellow spots. Legs originate underneath the armored back and often can't be seen from the top. When alarmed, pill bugs roll up into a tight ball, or "pill. They live in cracks, crevices, or even out in the middle of the lawn. Mainly active at night. Food: mainly scavengers, but will eat fresh plant material

Snails



Soft-bodied animals with a hard, coiled shell. Very small snails can be quite plentiful in lawns, especially ones around 1/16 inch. Food: fresh and decaying plant material.

Slugs

Look like snails without shells. Both snails and slugs travel on a slippery substance that they secrete; they thus leave a track where they have been. Food: fresh and decaying plant material.

Earthworms

Segmented worms with a large band around the body about 1/3 of the distance from the head. Size varies from 1 inch to over 6 inches. Earthworms are very numerous in lawns, frequently come up after the lawn is watered or at night. Food: scavenger; eating material in soil.

Big Animals

AMPHIBIANS

Almost all begin life in water with gills; later they develop lungs and come on land. Their skin is usually moist, either smooth or warty. Toads, frogs, and salamanders belong in this group. All of these animals may be found on lawns, but they are not regular visitors. Food: all are predators as adults.

Salamanders

Frogs

Toads

REPTILES

Have dry, scaly skin which they periodically shed. Snakes and lizards are common reptiles. Snakes are commonly found on lawns--lizards less often. Food: all snakes and most lizards are predators.

Snakes

Lizards

BIRDS

Have wings and feathers; nearly all fly. Many birds are common and important visitors to lawns. Robins, blackbirds, sparrows, and pigeons are pictured here. Food: robins are predators, feeding mainly on earthworms; blackbirds feed primarily on insects and spiders and on seeds; sparrows feed on insects and seeds; pigeons eat seeds almost exclusively.

MAMMALS

Have fur or hair and nurse their young on milk. Most mammals are more active at night than during the day. Food:

House Mouse

Eats seeds, or scavenges for whatever vegetable remains it can find.

Meadow Mouse

Eats grass and some seeds.

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Gophers

Live on roots of plants. (Gophers only leave dirt mounds at the entrance or exit to their tunnels; they seal their tunnels so you cannot stick your fingers into them.)

Moles

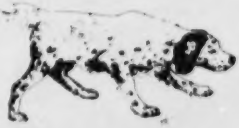
Eat animals like earthworms and grubs. (Moles make shallow tunnels and leave holes you can stick your fingers into.)

Squirrel

Do not feed directly on lawn, but will pick up or bury nuts on lawn.

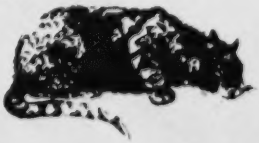
Dogs

Rarely eat on lawn, but do leave waste products (which serve as food for many other animals).



Cats

Occasionally eat gophers, mice, or moles.



Man

Very common; doesn't eat on lawn but does cut and remove grass. Kills big and small animals with traps and pesticides and plants with herbicides. Man also generally stomps on everything with his big feet.

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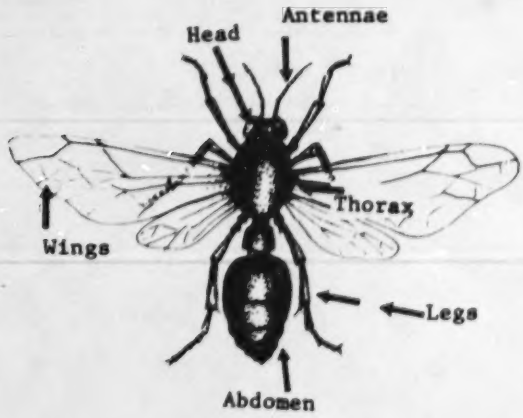
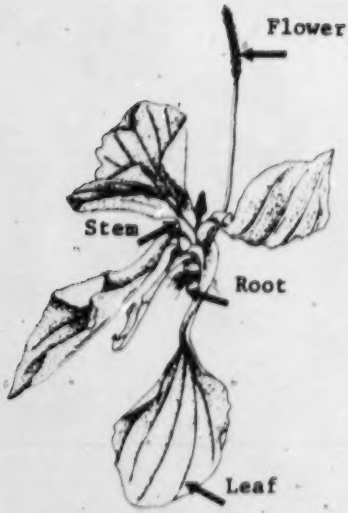

Head
Antennae
Thorax
Wings
Legs
Abdomen


Flower
Stem
Root
Leaf

GLOSSARY

Predator	An animal that eats other animals.
Herbivore	An animal that eats plants.
Scavenger	An animal that eats dead or decaying plant or animal material.
Annual	Plants that complete their life cycle from seed in one year.
Perennial	Plants that live longer than two years.
Biennial	Plants that don't flower until second year; complete life cycle in two years.
Runners	Long stems that grow close to the ground, rooting and sending up new leaves and stems.

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OBIS ABSTRACT

What Is OBIS?

Start with a group of young people in the out-of-doors and a biological concept or process as the basic ingredients. Add a large measure of fun; stir in the discovery approach; and season with a simulation, a game, a craft, or an interesting investigation. Mix thoroughly and you have one of the 100 activities that have been developed by the Outdoor Biology Instructional Strategies (OBIS) Project.

OBIS provides community-sponsored youth organizations and schools with learning activities for use at common outdoor sites such as lawns, local parks, city lots, neighborhood streams and ponds, and the seashore. Although the activities are intended primarily for ten- to fifteen-year-old youngsters, both younger and older people (including family groups) have enjoyed OBIS activites. Their easy-to-follow format, simple preparation and equipment, and short duration (usually one hour) make OBIS activities suitable for both the experienced outdoor-education leader and the first timer with no previous experience in biology. The activities may be used independently or sequenced to create a program to suit your needs. Scouts, Park and Recreation districts, religious groups, service groups, nature centers, summer camps, and schools are a few of the groups that have used OBIS activites in their outdoor-education programs. OBIS activities help youngsters and adults to better understand and appreciate the ecological relationships in their local environment.

How Were OBIS Activities Developed and Trial Tested?

The OBIS materials were developed at the Lawrence Hall of Science, University of California, Berkeley, and supported by a grant from the National Science Foundation. The materials were developed over a six-year period ending in 1978. Unlike many development projects, OBIS considered the testing of activities with youngsters to be an integral part of the development process. The OBIS activity development procedure is one of devising a strategy, trying it out numerous times with youngsters, making modifications and then retrying the revised activity. This testing,

revision, and retesting process was repeated on a local level and, in many cases, on a national level for each OBIS activity. To help gather national feedback on the trial edition activities, OBIS established a network of OBIS Resource Centers across the country. Over the past five years, OBIS has received thousands of feedback comments from OBIS users throughout the United States. This feedback is being used to revise the existing OBIS trial editions.

The OBIS Trial Editions are available through the Lawrence Hall of Science, University of California, Berkeley, California 94720.

Jan. 1979 OBIS Equipment Order Form*

***About June, 1979, Delta Education, Box M, Nashua NH 03061 will distribute these and other OBIS materials. Contact them for prices and ordering information.**

Shipping Address (Please print):

Name: _____ **Date:** _____

Address: _____

City: _____ **State:** _____ **Zip:** _____

Please send me the following items in the quantities indicated:

QUANTITY	ITEM — DESCRIPTION		UNIT SHIPPING WT. (Kg.)	TOTAL WT. (Kg.)	UNIT PRICE	TOTAL PRICE
	Blacklight bulb for safari lamp	each	.05		$8.97	
	Blacklight fluorescent tracing powder	20 gr. pkg.	.10		.95	
	Blueprint paper (22 cm x 30 cm sheet)	25 sh. pkg.	.20		1.75	
	Bug box	each	.01		.35	
	Colbat chloride crystals	110 gr. pkg.	.15		3.75	
	Colbalt chloride test paper (1 cm x 15 m roll)	each	.025		3.50	
	Colored cellophane (25 cm x 30 cm sheet)	red, each	.025		1.25	
		green, each	.025		1.25	
		blue, each	.025		1.25	
	Confectioners dye (10 grams in vial)	each	.020		1.00	
	Kodak Studio Proof F paper (20 cm x 25 cm sheet)	10 sh. pkg.	.15		2.75	
	Line level	each	.025		1.40	
	Litter Critter Wheels thermofax transparencies	1 set of 4 wheels	.050		.35	
	Magnifying lens (3 lenses: 3x, 5x, 8x, plastic frame)	each	.025		1.00	
	Meter tape	each	.025		.50	
	Ozalid paper (21.5 cm x 28 cm sheet)	25 sh. pkg.	.15		1.00	
	Plastic measuring cup (250 ml)	each	.020		.30	
	Plastic vials with lid (14 dram)	pkg. of 10	.150		1.30	
	Spring scale (2000 gram)	each	.070		3.00	
	Thermometer, calibrated in °C	each	.025		1.25	
	Tweezers	each	.10		.40	
	Water Breathers dropper	each	.010		.20	
	OBIS Lawn Guide	each	.05		.60	
	OBIS Pond Guide	each	.05		.60	
	OBIS Trial Edition, Set I	each	1.20		8.50	
	OBIS Trial Edition, Set II	each	1.20		9.50	
	OBIS Trial Edition, Set III	each	1.20		10.50	
	OBIS Trial Edition, Set IV	each	1.20		11.50	
	The OBIS Trail Module	each	.05		2.00	

	Subtotal Wt. (Kg.)	**Subtotal**
	California sales tax for California residents only: (6% California residents) (6½% Bart County residents)	
	Shipping fee (see reverse)	
	TOTAL DUE	

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Regents of the University of California

☐ Please bill me. (Minimum order: $10.00)

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University of California
Berkeley, California 94720

☐ Please check here if you desire air mail shipment.
OTHERWISE ALLOW FOUR WEEKS FOR DELIVERY
(Air mail takes approximately one week.)

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PLEASE RECHECK YOUR COMPUTATIONS AND BE SURE THAT THE SHIPPING FEE IS CORRECT.

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Rec'd on _____ By _____ Shipped on _____ By _____

To Determine Your Shipping Fee:

1. **Total the weight of merchandise.**
2. **Use Table A to find your shipping zone.**
3. **If you desire surface shipment, find the shipping charge in Table B. Allow at least four weeks for delivery.**
4. **If you prefer faster (1 week or less) airmail shipment, check the box on the front of this form, and find the shipping fee in Table C.**
5. **Enter the shipping fee in the appropriate box on the front of this form.**

Table A — Shipping Zone

Zip Code Prefixes	Zone	Zip Code Prefixes	Zone	Zip Code Prefixes	Zone	Zip Code Prefixes	Zone	Zip Code Prefixes	Zone	Zip Code Prefixes	Zone
006-008	8	530-534	8	674-679	6	770-787	7	850-864	5	955	3
		535-540	7	680-681	7	788	6	860-864	4	956-959	2
100-199	8	541-543	8	683-693	6	789	7	865-880	5	960-961	3
		544-567	7			790-797	6	881-882	6	962-966	1
200-299	8	570-577	6	700-704	8	798-799	5	883	5	967-969	8
		580-582	7	705-706	7			884	6	970-974	4
300-379	8	583-588	6	707-708	8	800-826	5	890-893	4	975-976	3
380-381	7	590-591	5	710-729	7	827	6	894-897	3	977-979	4
382-385	8	592-593	6	730-739	6	828-832	5	898-899	4	980-985	5
386-387	7	594-599	5	740-745	7	833	4			986	4
388-399	8			746	6	834-835	5	900-928	4	987-992	5
		600-609	8	747	7	836-837	4	930-935	3	993	4
400-499	8	610-617	7	748	6	838	5	936-939	2	994	5
		618-619	8	749-762	7	840-844	4	940-951	1	995-997	8
500-508	7	620-667	7	763-764	6	845	5	952-953	2	998	7
510-511	6	668-672	6	765-767	7	846-847	4	954	1	999	6
512-528	7	673	7	768-769	6						

Table B — Surface Shipment

WEIGHT UP TO:		.5 Kg.	1 Kg.	2 Kg.	4 Kg.	6 Kg.	8 Kg.	10 Kg.	12 Kg.	14 Kg.
YOUR	1-3	1.50	1.50	1.50	1.75	2.00	2.25	2.50	2.75	3.00
ZONE	4-6	1.50	1.50	1.75	2.25	2.75	3.25	4.00	4.50	4.75
	7-8	1.75	2.00	2.50	3.25	4.50	5.50	6.50	7.75	8.75

WEIGHT UP TO:		16 Kg.	18 Kg.	20 Kg.	22 Kg.	24 Kg.	26 Kg.	28 Kg.	30 Kg.
YOUR	1-3	3.25	3.50	4.00	4.25	4.50	5.00	5.50	6.00
ZONE	4-6	5.50	6.00	6.50	7.25	7.25	8.00	8.50	8.75
	7-8	10.00	11.00	12.00	13.00	14.00	15.00	16.50	17.25

Table C — Air Mail Shipment

WEIGHT UP TO:		.5 Kg.	1 Kg.	2 Kg.	3 Kg.	4 Kg.	6 Kg.	8 Kg.	10 Kg.	12 Kg.
	1-3	2.25	2.50	3.25	4.00	5.00	6.50	8.00	10.25	11.00
Z	4	2.25	2.50	3.25	4.00	5.00	6.50	8.00	10.25	11.00
O	5	2.25	2.50	3.25	4.00	5.00	6.50	8.00	10.25	12.00
N	6	2.50	3.00	3.75	4.50	5.75	7.75	10.75	11.75	14.00
E	7	2.50	3.00	3.75	4.50	5.75	7.75	10.75	13.00	15.00
	8	2.75	3.25	4.25	5.25	7.25	9.00	12.00	14.25	17.00

WEIGHT UP TO:		14 Kg.	16 Kg.	18 Kg.	20 Kg.	22 Kg.	24 Kg.	26 Kg.	28 Kg.	30 Kg.
	1-3	13.25	15.25	17.00	19.00	21.00	21.00	25.00	27.00	29.00
Z	4	13.25	15.25	17.00	19.00	21.00	22.00	27.00	27.00	29.00
O	5	13.25	15.25	19.00	20.00	22.00	24.00	29.00	30.00	31.00
N	6	16.00	19.00	22.00	22.00	25.00	27.00	30.00	32.00	34.00
E	7	16.00	20.00	24.00	25.00	28.00	30.00	33.00	35.00	38.00
	8	20.00	22.00	26.00	27.00	31.00	33.00	37.00	43.00	44.00